Instruments

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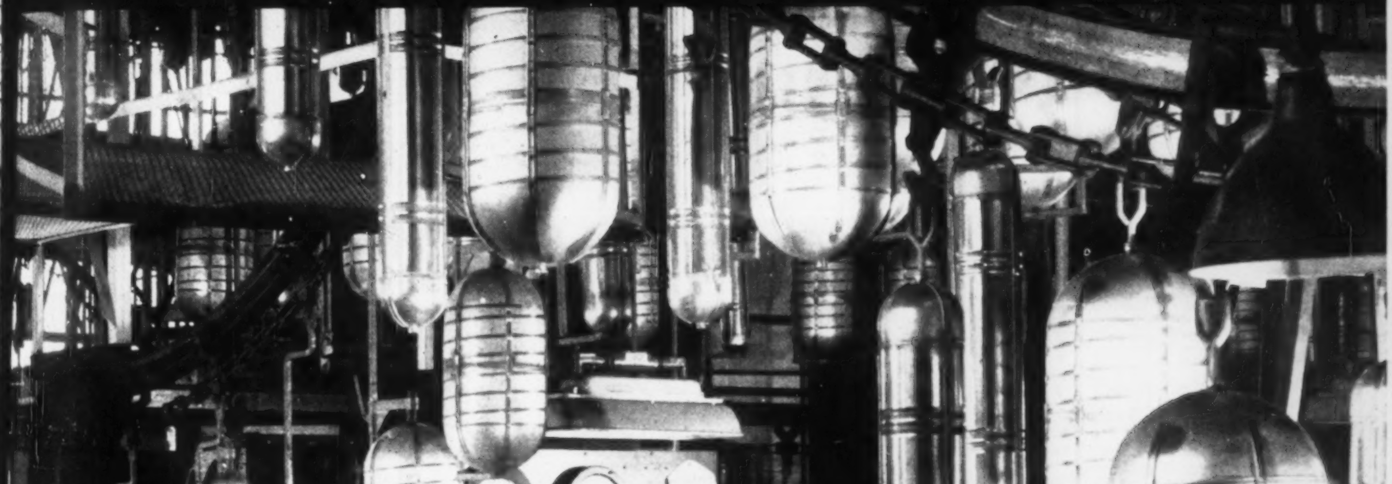

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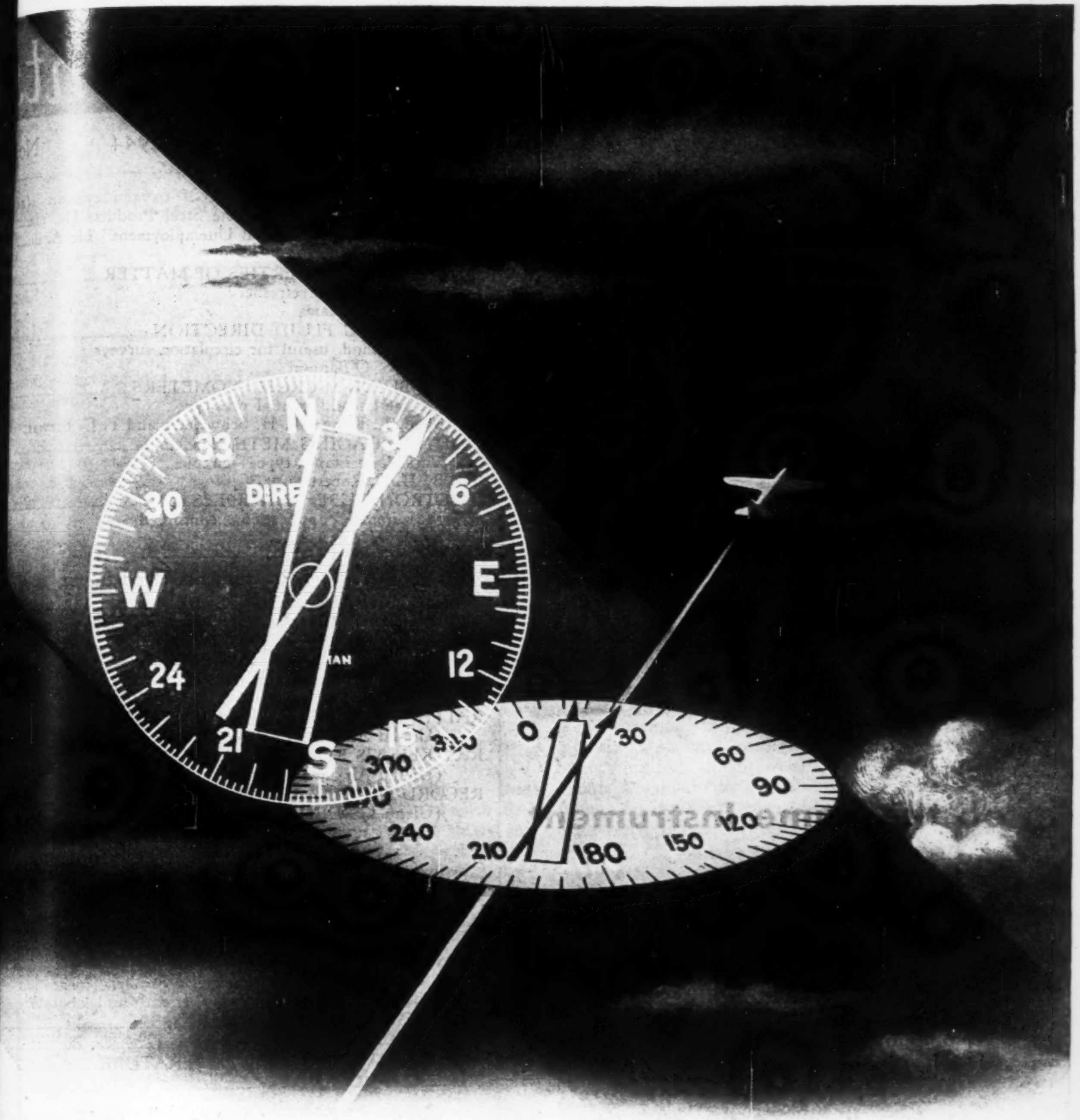

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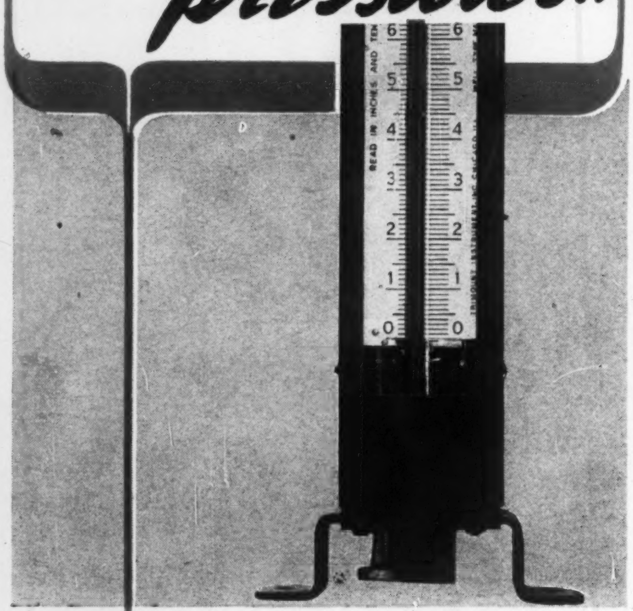

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Vol. 17 **DECEMBER 1944** No

COVER: Testing new shatterproof oxygen cylinders (a
used on B-29s) at Firestone Steel Products Co. plant
EDITORIAL: "Technological Unemployment" Lie Again
By M. F. Behar
THE ELASTIC PROPERTIES OF MATTER
Another useful "refresher"
By S. R. Williams
DETERMINING FLUID DIRECTION
New method, useful for circulation surveys
By L. S. O'Bannon
EASILY-BUILT MICROMANOMETERS
for line and differential pressures
By E. R. Klinge, P. H. Schweitzer and F. C. Stewart
ELECTRIC GAGING METHODS
Variable-resistance types—circuits
By H. C. Roberts
ELECTRON TUBE PRINCIPLES
Measurement applications, continued
By A. W. Kramer

Aviation Instruments Department

AAF BEARING REPAIRS SPEEDED
By Colonel William Turnbull
ELECTRICAL COMPUTING GUNSIGHT
(Fairchild C & I Corp.)
EDITORIAL: Other Industries Profit
By M. F. Behar
RALPH JOHNSON'S "COORDINATOR"
(United Air Lines)
RAY KELLY'S STALL-WARNING SYSTEM
(United Air Lines)
RECORD-BREAKING BORESCOPE
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INSTRUMENT SOCIETY NEWS
MANUFACTURERS' NEW LITERATURE
ADVERTISERS' INDEX

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Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

"Technological Unemployment" Lie Reappears

TO young readers this expression "technological unemployment" is unfamiliar: it may have been forgotten by many older readers. It had been defined in various ways but in general it referred to *permanent* ousting of workers from jobs because some jobs are made forever unnecessary by labor-saving inventions. Alleged consequences: bread-lines, apple-selling, "Hoovervilles" on the outskirts of cities where $20 cover-charge night-clubs are packed by those who profit from the brain-children of starving inventors . . . poverty in the midst of plenty.

That's the definition which gained some vogue between 1930 and 1933 . . . Remember?

This view was widely held—not only by non-technical clergymen, newspaper editors, politicians (and their audiences) but even by some men in Industry. In 1934 a brilliant engineer, financially successful as a just reward for his automatic-control inventions, brought out a book entitled "The Great God Waste" in which he castigated the "system" of capitalistic democracies—in which he declared that his conscience hurt when he thought of the tens of thousands of men whom he had made jobless. He died soon after this outburst on "technological unemployment," still believing that his inventions had created poverty. It was pitiful, for his inventions had created wealth—wealth for the many. The fact is that—as has often been declared on this page—AUTOMATICITY MAKES JOBS. This has been proved by the automobile industry and its service industries. Few horseshoers, whip-makers, etc., were thrown out of jobs; hardly any at all permanently. Those not on the point of retiring voluntarily—those who wanted work—did keep on working, at higher wages and under better conditions.

Beneficial Technological Displacement

But instead of reprinting a brief summary of our old editorials on how Instrumentation makes jobs and creates wealth, we call attention this month to a new proof of this old dictum: the advantages of TECHNOLOGICAL DISPLACEMENT.

This is the correct term for what happens *locally* and *transiently* when a manual process is automatized. It is the germ of shining truth which is veiled by the voluminous folds of the dark fabric of the "technological unemployment" lie. This lie, in fact, consisted essentially in shouting that technological displacement was a bad thing. Nobody could prove that it was a bad thing, because there was no adequate testing-ground, but by the same token nobody could prove that it was a good thing, so the Big Lie stuck.

Now, however, the War Effort provides an enormous testing-ground, and I firmly believe that there is an overwhelming mass of evidence that technological displacement *attributable to increased productivity* is a good thing.

That it is a good thing for our beloved Nation is proved beyond doubt by "the miracle of production."

That it is a good thing for the individual worker is fairly well proved by THE RAPIDITY OF UPGRADING.* You yourself may be "exhibit No. 2,000,000." If not, then you can name several friends who have been rapidly upgraded and none who has suffered from these displacements.

Yes, I firmly believe that the once-feebly-shining truth about technological displacement has grown to be a searchlight which soon will be visible through the dark folds of the Big Lie . . . visible eventually to all the people if mass-circulation editors and commentators proclaim to tens of millions this truth hereby proclaimed to tens of thousands . . . visible, however, only IF the Big Lie does not spring forth again in more vicious form . . . as it may this year or next.

Light Must Prevail Over Gloom

The fools and knaves who wield the dark folds of the Big Lie are preparing to blindfold the public with it. In the last fortnight some writers and radio orators have apparently held a dress rehearsal of what may be a propaganda of fear to be let loose on VE Day. Each prophet of gloom represents some selfish pressure-group; each has his own technique; the commonest is this: "If my group doesn't get the laws and rulings it wants, there will be nearly twenty million unemployed." The measures desired by the group are made to sound desirable for the entire nation, though in reality they are hoggish demands for an unjustly high share of the nation's money.

One of the contemptible tactics of the greed-group spokesmen is the twisting of recent good news into evil portents. For example, recent WPB announcements of enormous increases in productivity are good news to you and me because accelerated production makes possible the Cycle of Abundance with lagless absorption of veterans and war workers into peace-goods industries busily turning out cars, prefab houses, furniture, radios, etc., for which the demand *and* the war-bond savings *both exist*. But the greed-group gloom-peddlers, shamelessly drawing the opposite inference, pounce upon the WPB report to make the public believe that increased productivity, as soon as war production ceases, will turn prosperous America into something like starving India —where productivity is at its lowest level!

Thus does the Big Lie of "technological unemployment" reappear as a 1945 model.

Let's all fight to nip it in the bud! —MFB

---

*I don't mean higher wages for the *same* performance at old levels of productivity—an entirely different matter, although it is a fact that automatized industries pay higher wages for "window-washing" (unchanged hand jobs).

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and thereby registers the end of the seventeenth year of *Instruments'* service to users of measurement and control devices—service to the

UNITED STATES OF AMERICA

The entire staff of *Instruments* wishes you

A Merry Christmas and a Happy New Year

THE ELASTIC PROPERTIES OF MATTER

A "Refresher" for Instrument Men

By **S. R. WILLIAMS, Professor of Physics, Amherst College, Amherst, Mass.**

In studying the way matter is held together we considered, in the April issue of *Instruments*, a simple material such as ordinary table salt. We saw that the atoms of sodium and of chlorine went together in an orderly cubic arrangement, alternating one with the other. We also saw that these atoms were held together by ionic bonds. If now one takes a crystal of salt and distorts it a little, it will be observed to come back to its original form and dimensions. There is a resistance offered to changing the distances between the atoms either by pulling or compressing them or by changing the form of the crystal. This tendency for a body to return to its original shape and dimensions is called the elastic property of that body and there are two distinct forms of Elasticity, viz., Elasticity of Form and Elasticity of Volume. They are due to the forces which act between the atoms and molecules composing a body.

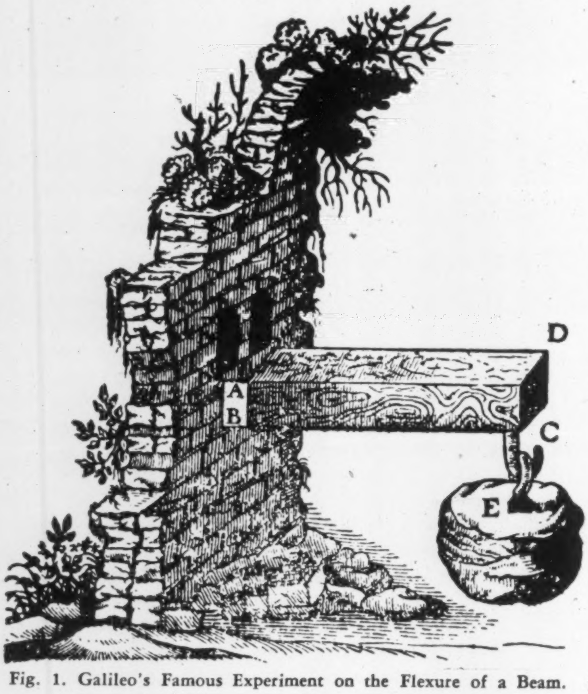


Fig. 1. Galileo's Famous Experiment on the Flexure of a Beam.

By defining Elasticity as the tendency of a body when distorted a little to return to its original form or volume, we cut across a general misconception in thinking of rubber as being highly elastic. If we compare a rubber and steel ball of the same dimensions we will find the tendency for the steel ball to return to its original form or volume to be much greater than the tendency which rubber possesses. This is borne out by the elastic constants for rubber and for steel in that the former has a value (roughly) about 2.85×10^7 dynes/cm.^{2} while steel has a value around 19×10^{11} dynes/cm.^{2} for its elasticity of stretch.

In listing the famous Elasticians previous to 1850, Todhunter places that indefagatible scientist, Galileo Galilei, at the head of the list. It is to him that we owe the direction which the investigations have taken, since his day, concerning the elasticity and strength of materials. Much of Galileo's work has had to be revised, but his famous problem of the flexure and breaking of a horizontal beam (Fig. 1) started the present trend of thought concerning elasicity.

Among the many investigators who followed along the path started by Galileo was Robert Hooke, who in his work *De Potentia Restitutiva* (London, 1678) stated that 18 years previously he had found: "The power of any spri is in the same proportion with the tension thereof." Hoo does not mean here a spiral wire spring, but any "sprin body" whatever, for he goes on to say:

> From all which it is very evident that the rule or law of Nature in every springing body is, that the force or power to restore itself to its natural position is always proportional to the Distance or Space it is removed therefrom, whether it be by rarefaction, or separation of its parts the one from the other, or by a condensation, or crowding of those parts nearer together. Nor is it observable in these bodies only, but in all other springy bodies, whatever, whether metal, wood, stone, baked earth, hair, horns, silk, bones, sinews, glass and the like. Respect being had to the particular figures of the bodies bended, and to the advantageous or disadvantageous ways of bending them.

To put Hooke's law into modern dress, it can be expressed as follows:

$$\frac{\text{Integral Stress}}{\text{Integral Strain}} = \text{a constant,}$$

which constant is called the Coefficient of Elasticity or th Modulus of Elasticity.

As indicated above there are two kinds of Elasticity elasticity of form and elasticity of volume. Hooke's la may be applied to both kinds of elasticity. In the case tha a force is applied to a body so as to distort its form, th coefficient of elasticity is called the coefficient of rigidit and when the volume is changed the ratio between th stress and the strain is known as the Bulk Modulus or th coefficient of volume elasticity. There is still a third modulus which involves both of the preceding moduli. It has t do with the ratio of the stress of a stretching or compressing force to the strain thereby produced. It is called th Modulus of Stretch or Compression or, more familiarl Young's Modulus.

BULK MODULUS OR VOLUME ELASTICITY

In applying Hooke's general law, Stress/Strain = Const to the problem of volume elasticity it will be understoo that by the term stress is meant the force per unit area o the body which is applied to change the volume, while th strain means the change in volume per unit volume. I changing the volume of a body the force per unit area is a hydrostatic pressure which is everywhere applied norma to the surface of the body.

The easiest case to be considered is that of a gas. In Fig 2, is a cylinder with a tightly-fitting but frictionless pisto and on the piston may be laid different weights. The mass of the weights multiplied by the acceleration due to gravity gives the force applied to the piston $= mg$. Dividing this by the area A of the piston gives the pressure P applied to the gas, and this pressure, by Pascal's law, is transmitted undiminished to all parts of the gas. The volume of the gas is that of the containing cylinder which is $A \times L$ where L is the distance between the bottom of the cylinder and the lower surface of the piston. Let a certain weight be placed

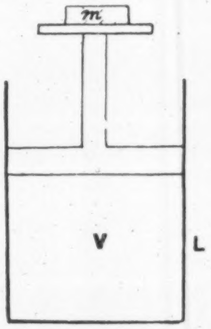


Fig. 2. Simple Outfit for Measuring the Bulk Modulus of a Gas.

n the piston's platform and the volume $V = A\,L$ will be iminished by a small amount v. By our previous definitions e bulk modulus E will be

$$E = \frac{\text{Stress}}{\text{Strain}} = \frac{mg/A}{v/AL} = \frac{P}{v/V} = \frac{PV}{v}$$

here E will be expressed in terms of pounds or poundals er square inch depending upon whether we use mg or just as a force. It can also be expressed in dynes or grams er square centimeter.

Any substance can be put under hydrostatic pressure as as illustrated in Fig. 10 in the April issue of *Instruments,* y means of the piezometer. Usually, optical devices are sed in observing the changes in dimensions of a body hen thus compressed and from which the change in vol-me per unit volume, v/V may be determined and placed n the foregoing formula for bulk modulus.

COEFFICIENT OF RIGIDITY OR ELASTICITY OF SHAPE

Suppose we consider a cube of any solid material as hown in (a) Fig. 3. If the bottom of the cube is held in a fixed position and a force F applied to the edge of the upper surface, the cube can be sheared over into the form (b) in Fig. 3. A distorting force has changed a cubic form of solid or rigid material over into a rhombohedron and this sort of change, when it returns to its original form, is called elasticity of form. Let A be the area of the upper surface of the cube, then the ratio F/A is the distorting stress and if the edge of the upper surface is moved a distance d and the height of the cube is D then d/D is defined as the strain so that the coefficient of rigidity n may be expressed by the equation

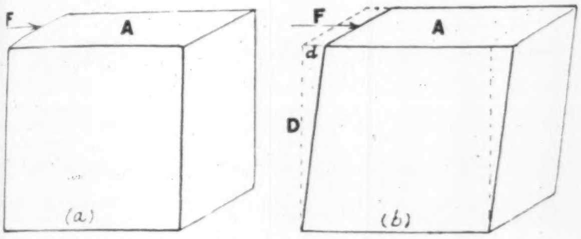
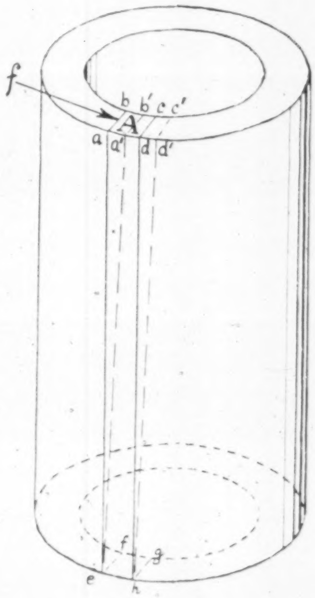


Fig. 3. A Cube distorted by a shearing Force, F.



ig. 4. When the cylinder is twisted he section *abcdefg* is sheared into the osition, *a' b' c' d' efgb,* analogous to he shear in (a) and (b) in Fig. 3.

$$n = \frac{F/A}{d/D} = \frac{FD}{Ad}$$

Inasmuch as both d and D are distances the units in which n will be expressed will be in force per unit area.

The process for measuring the coefficient of rigidity just outlined is not an easy way for doing it. Experience has shown that it can be easily and accurately determined by a torsional process.

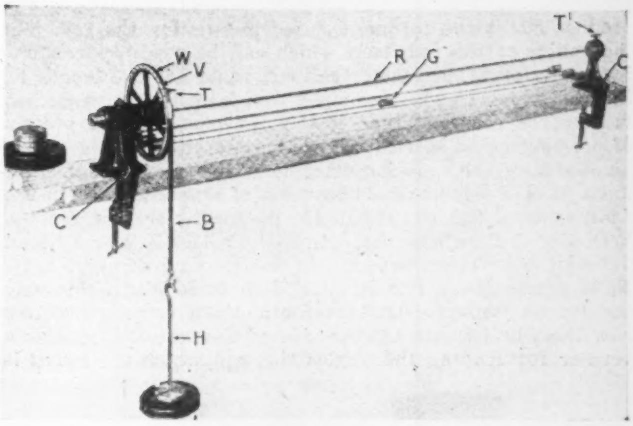


Fig. 5. A Torsion Lathe whereby a steel Rod, *R*, may be twisted for determining the Coefficient of Rigdity.
(Courtesy Central Scientific Co.)

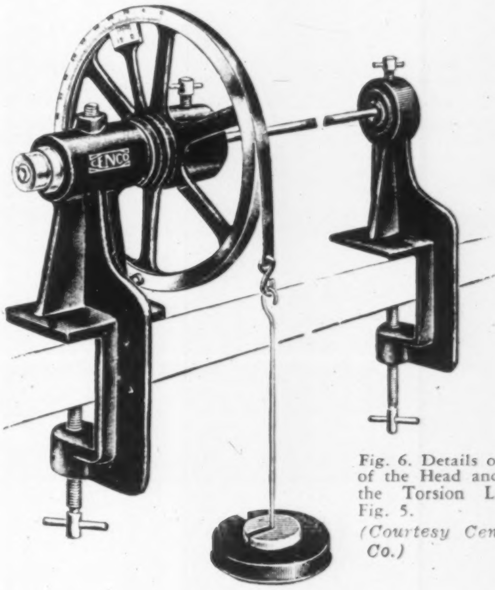


Fig. 6. Details of the Wheel and of the Head and Tail Chuck of the Torsion Lathe shown in Fig. 5.
(Courtesy Central Scientific Co.)

Suppose one takes a hollow cylinder of some metal, as an example, and twists it as shown in Fig. 4. Let the lower end of the cylinder be the fixed end, then as the upper end is twisted it will be observed that the section *abcdefgh* of the cylinder is sheared over into the form *a'b'c'd'e f g h*, exactly similar to the distortion in Fig. 3. Instead of taking a hollow cylinder, one may take a solid cylinder, or rod, and put it into a torsion lathe as in Fig. 5. One can think of the solid cylindrical rod as made up of a series of concentric hollow cylinders and, when these are summed up by a process of integral calculus, an equation will be derived* which takes the form of the coefficient of rigidity as follows:

$$n = \frac{2FRl}{\pi\phi r}$$

In this equation ϕ is the angle in radians through which one end of the rod T in Fig. 5 is twisted with respect to the other end T', which is fixed. F is the force applied to the scale pan H and is given by the equation $F = mg$ in which m represents the mass laid on the scale pan and g is the acceleration due to gravity at the point where the experiment is performed. (Most engineers will prefer to express F in pounds.) R is the radius of the wheel W and is the torque arm to which the force F is applied, so that the product FR is the torque, Q, used in twisting the rod. r is the radius of the rod itself which can be readily measured by means of a micrometer caliper, while l is the length of the rod which can be measured with a meter or yardstick. It must be observed that if the foot-pound-second system of measurements is used, all of the quantities on the right-hand side of the equation must be in terms of fundamental units in that system, and the value of n will then be in the f.p.s. system. The same holds for the metric or ç.g.s. system.

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*The derivation of this equation will be found on pages 118-122 of "Foundations of College Physics" (Ginn and Co., Boston, 1937), a text for use in connection with these "refresher" articles.

In Fig. 5 it will be noted that the wheel W has a broad flat edge over which runs a thin flexible strip of metal tape, B, to whose lower end is applied to force F. In this way the torque remains constant for a given force no matter how the wheel turns. On the side of the wheel, Fig. 6, is a vernier for reading the angles through which the rod R is twisted. G in Fig. 5 points to other rods than R whose diameters are different from the one in the torsion lathe. The lengths of the rods may also be varied by moving the chuck C at the right of the lathe nearer the head chuck.

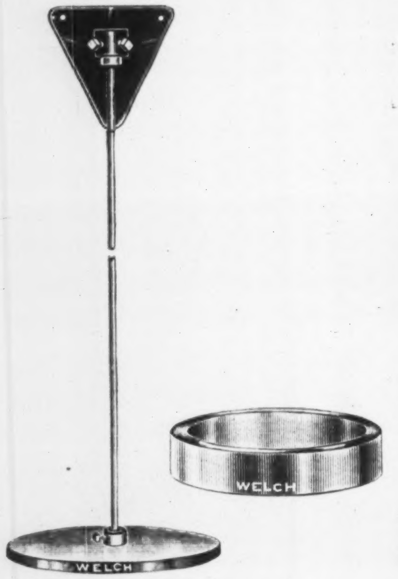


Fig. 7 (left). A Torsion Pendulum suspended by a substantial Support. Fig. 8 (right). The Ring in Fig. 7 is here shown in position for obtaining T_2.

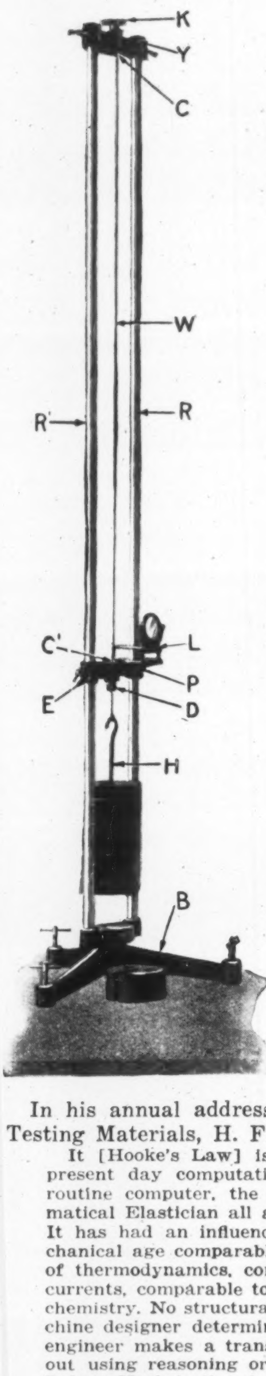
(Courtesy W. M. Welch Mfg. Co.)

Tests like the one just described must be made on all materials going into machinery like the shafting between the engine of one's auto and the rear axle, or like the shafting between the engines of a large transatlantic liner and its propellers, or like the propeller shafts of an airplane.

Not only can the coefficients of rigidity be determined by the outfit just described, but also by adding sufficient load one can arrive at the point of elastic limit and determine the fracture point where the rod will shear and break. Such factors must all be known and figured out beforehand when the engineers start to calculate what size of driving shaft must be used in order that no breakdowns will ensue. In the two kinds of elasticity just described it will be seen that both forms are dependent upon the interatomic forces which hold the particles together and therefore a more complete understanding of these forces is necessary as was emphasized in the April instalment on the Constitution of Matter.

Many parts of machinery are subjected to twists which are periodically a to-and-fro motion which subjects parts of machinery to fatigue and subsequent failures. The importance of these tests on the elastic properties of bodies, the determination of their elastic limits and breaking points cannot be overemphasized.

When Hooke enunciated his law of elasticity in the Latin form "Ut tensio sic vis" which is today freely translated as "Strain is proportional to Stress," he set in motion a tremendous sequence of investigations and researches on the subject of the Elastic properties of bodies.



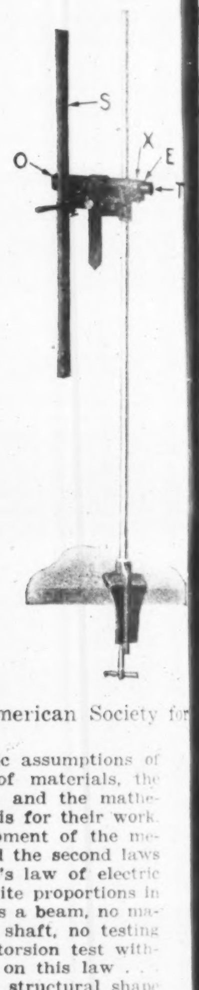


Fig. 9 (left). Apparatus for measuring th values of Young Modulus, or the Modulu of Stretch, for different kinds of Wires. Fi 10 (right). Telescope and Scale for measur ing Elongations of Wires when stretched

(Courtesy Central Scientific Co.

In his annual address before the American Society for Testing Materials, H. F. Moore said:

> It [Hooke's Law] is one of the basic assumptions of present day computation of strength of materials, the routine computer, the testing engineer, and the mathematical Elastician all accept it as a basis for their work. It has had an influence on the development of the mechanical age comparable to the first and the second laws of thermodynamics, comparable to Ohm's law of electric currents, comparable to the law of definite proportions in chemistry. No structural engineer designs a beam, no machine designer determines the size of a shaft, no testing engineer makes a transverse test or a torsion test without using reasoning or formulas based on this law . . . Robert Hooke's thumbmark is on every structural shape and on every stress-carrying forging or casting; it is on every timber bent and post. He takes his place among the chemists and the metallurgists and the electricians and the steam engineers who ushered in the mechanical era."

All hail to the little man with the large mind who taught us to say, "As the stretch, so the force."

In speaking of a to-and-fro vibration of parts of machinery it has been found that this very effect may be put to use in the determination of the coefficient of rigidity. This can be done with a torsion pendulum like the one shown in Figs. 7 and 8.

One may use the same rods as were employed in the torsion lathe. The rods are suspended by the upper end in a rigid clamp as shown in Fig. 7. To the lower end is clamped a disk whose diameter is approximately 10 cm. When this disk is twisted through a small angle (5-10 degrees) and then released it will continue to oscillate for some time about an axis which is that of the rod. The period of vibration is given by the formula:

$$T_1 = 2\pi\sqrt{I/Q_0}$$

in which $Q_0 = FR/\phi$ in the equation for n on the torsion the. Q_0 is called the moment of torsion and is the torque necessary to twist the rod through one radian. I is the moment of inertia (rotational inertia) of the disk and is equal to $MR^2/2$ wherein M is the mass of the disk and R is its radius.

At the start of the experiment the ring in Fig. 7 may be hung over the upper support while the period is taken for the disk alone. Next the ring is lowered and placed carefully in a concentric position with the disk as in Fig. 8. The moment of inertia of the ring, $I_0 = M(R^2_i + R^2_0)/2$ where R_i and R_0 are respectively the inner and outer radii of the ring, hence the new period, T_2, with the ring mounted in position will be

$$T_2 = 2\pi\sqrt{(I + I_0)/Q_0}$$

By eliminating the value of I from the two equations for T_1 and T_2 we obtain a formula for Q_0 such that

$$Q_0 = (I_0\pi^2)/(T^2_2 - T^2_1)$$

This value of Q_0 can now be substituted in the equation for n as follows

$$n = \frac{2FRl}{\pi\phi r^4} \text{ or } n = \frac{2Q_0 l}{\pi r}, \text{ in which } \frac{FR}{\phi} = Q_0,$$

where as before l is the length of the rod and r its radius.*

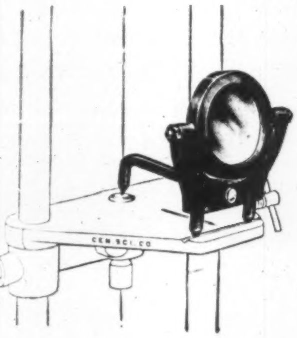


Fig. 11. Arrangement of Mirror in Fig. 9, shown in greater detail.
(Courtesy Central Scientific Co.)

YOUNG'S MOLULUS OR MODULUS OF STRETCH

Before a bridge engineer starts to build a great suspension bridge, he must know the elastic properties of the wires which go to make up the huge cables necessary to support the maximum load and still have a good margin of safety. The cables will stretch, and it must be known beforehand how far they will stretch, because they musn't stretch and sag too much.

The equipment for measuring the modulus of stretch for wire is shown in Fig. 9 and Fig. 10. In a substantial steel frame, Fig. 9, is hung a wire W. At C is a special chuck for gripping very firmly the upper end of the wire W. C' is another chuck fastened securely onto the wire near its lower end. The chuck C' is arranged to play freely up and down in the frame E, but a slot and pin prevents the chuck from twisting around circularly. On an extension of E rests an optical level L, with two feet of its tripod base resting in a groove in E while the third leg rests on the chuck C'. When a load is placed on H the wire elongates and the chuck C' moves downward through the frame E causing the mirror on L to tip. Detail of mirror is shown in Fig. 11. It is from the amount of the tipping of this mirror that the stretch of the wire can be measured. This is done in the following way: Fig. 10 shows a telescope T and scale S which is at a distance of 2 or 3 meters (6-9 ft.) from the part shown in Fig. 9. The telescope is adjusted until the image of the scale can be seen through the telescope by reflection from the mirror on L in Fig. 9. The latter can be tipped up and down independently of the tripod which carries the mirror. Fig. 12 will show the light rays as they pass from the scale to the mirror and then back to the telescope.

Let l be the amount the chuck, C', sinks when the load is put on. OP is the distance from the leg of the tripod which rests on the chuck to the middle point between the two front legs of the mirror. When the rear leg of the tripod sinks the base of the tripod and therefore the mirror turns through and angle θ. If, before the load was put on, light from the scale at T went out to the mirror and back on itself to the telescope, then after the load was put on, only light from the point L on the scale, Fig. 12, would finally arrive back on the cross-wire in the eye-piece of the telescope. In other words, since the angle of reflection is equal to the angle of incidence, the reflected beam has been turned through an angle 2θ while the mirror has turned just half of that amount. This point will be made clearer by considering the line θE the normal to the surface of the mirror. It will be seen from Fig. 12 that there are two similar triangles POS and EOT such that $PS = l : OP = ET : OT$ whence $l = OP\dfrac{ET}{OT}$ which is the elongation of the wire due to a given load on the scale pan. ET is half of the scale deflection as seen in the telescope and OT is the distance between scale, S, and mirror L in Figs. 9 and 10.

The equation by which the modulus of stretch Y, may be ascertained is derived from Hooke's law:

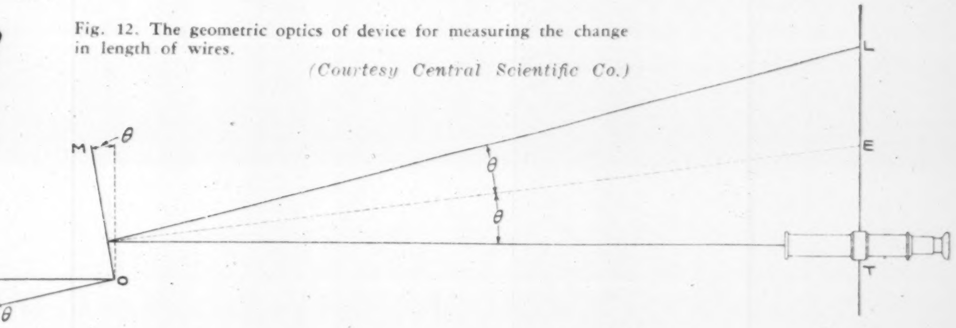


Fig. 12. The geometric optics of device for measuring the change in length of wires.
(Courtesy Central Scientific Co.)

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{\dfrac{\text{Force}}{\text{area of cross-section of wire}}}{\dfrac{\text{elongation of wire}}{\text{length of wire}}} = \frac{\dfrac{F}{\pi r^2}}{\dfrac{l}{L}} = \frac{FL}{\pi r^2 l}$$

In this equation r is the radius of the wire, l the change in length for the total length L, while F is the force. Y will again be expressed in force per unit area. In Fig. 13 is graphically shown the relation between the stresses and

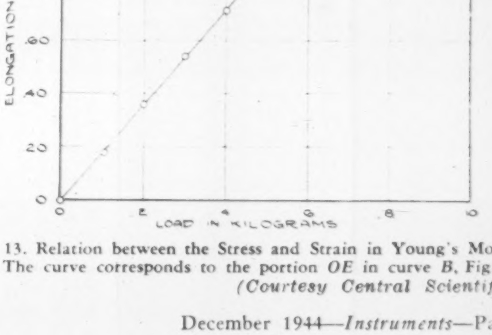


Fig. 13. Relation between the Stress and Strain in Young's Modulus. The curve corresponds to the portion OE in curve B, Fig. 15
(Courtesy Central Scientific Co.)

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*Further reference to this method may be found in Millikan's "Mechanics, Molecular Physics and Heat."

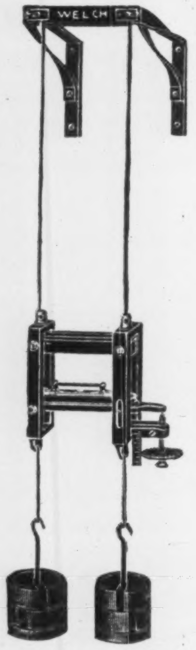


Fig. 14. Apparatus for measuring Young's Modulus and at the same time minimize temperature effects.
(Courtesy W. M. Welch Mfg. Co.)

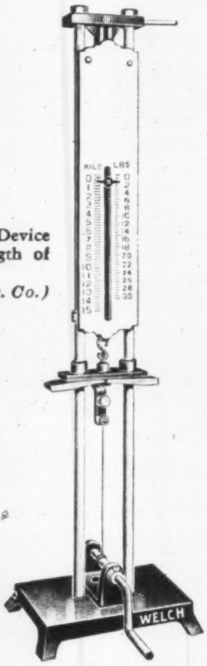


Fig. 16. A simple laboratory Device for testing the breaking Strength of Wires.
(Courtesy W. M. Welch Mfg. Co.)

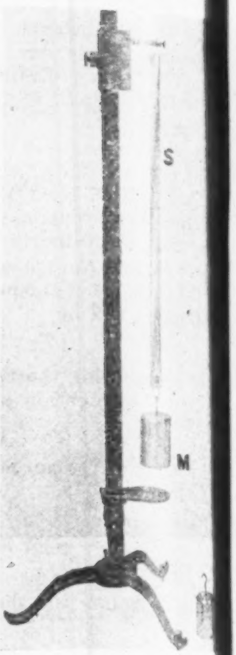


Fig. 17. A Helical Spring as it is stretched, or twisted, illustrates the Elasticity of Stretch, or the Elasticity of Form.

strains in measuring Young's Modulus. The slope is constant, because Stress/Strain = Constant.

If any temperature changes occur during the measurements of the modulus of stretch, changes in length due to changes in temperature will also register on the scale readings.

Fig. 14 shows a form of apparatus which seeks to obviate this difficulty. Two identical wires are hung up side by side with a level between the lower chucks on the two wires. If one is loaded more than the other the level will be thrown out of balance which can be restored by turning up or down, as the case may be, the micrometer caliper screw, the point of which pushes on the under side of one end of the level. The amount the micrometer screw is turned up to bring the level bubble back to the center again is the amount the one wire has elongated, l, due to the extra load put on it. This value of l and the load can be substituted in the equation for Y. If temperature changes occur it is assumed that both wires will be affected equally and therefore, no change in level of the measuring instrument.

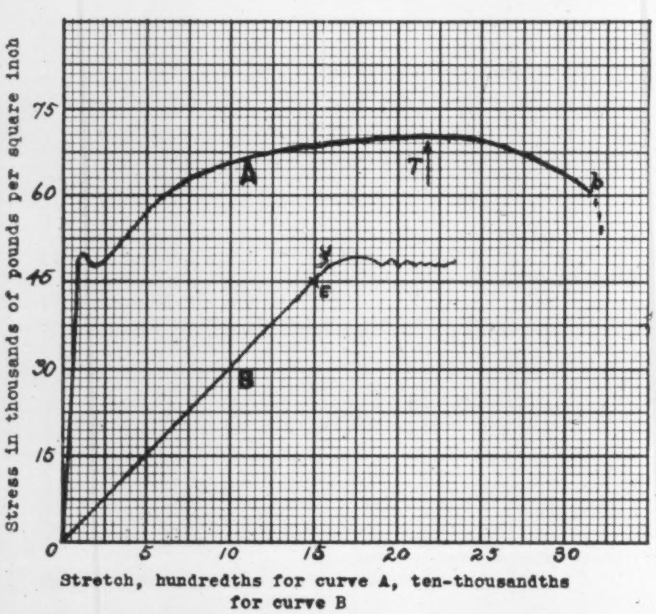


Fig. 15. Relations of Stresses and Strains as a Wire, or Rod, of Metal is elongated. B is an enlarged portion of A, viz., from O to the first bump.

By increasing the load on the stretching of a wire, load will finally be attained called the Yield Point as show at y in Fig. 15. Beyond this load we have exceeded t elastic limit and beyond this point Hooke's law complete breaks down. The maximum stress beyond the yield poi and indicated by T is called the tensile strength of the m terial. This is a highly important point in so much of o present-day structural steel work. The building of airplan must constantly take this point into account. The tot elongation of a sample of steel at the breaking point Fig. 15, is an important indication of the toughness the steel.

In Fig. 16 is shown a small laboratory device for testin the breaking strengths of different kinds of wires.

The wire is connected between the lower end of a sprin dynamometer and a small crank axle on which the wire ca be wound. As the wire is wound up the spring dynamomete elongates until the wire breaks and the reading on th scale at that moment represents the breaking force of th particular wire. This can then be expressed in terms stress, $F/\pi r^2$, or force per unit area.

These last two studies have dealt with stretching prope ties. The same formula holds for compressive stresses. Thi is equally as important as the stretching when one consider the thrusts and pushes in cantilever bridge building or fo any type of bridges formed by struts and beams. In a sky scraper like the Empire State Building in New York City the steel frame carries all the load of the superstructur and the stone and brick which form the surface of th building. This means a tremendous compressive stress o the frame where it enters the ground to finally rest on th rocky substratum. This means that Young's Modulus mus be known before construction begins because the steel cross piece under the threshold of the front door must at the be ginning of construction be many inches above the positio it will occupy when the building is completed, the reaso being that as load is added to that part of the building above the threshold, the farther will the threshold sink because the part of the steel structure below the ground is being compressed. This must all be figured out ahead o time.

To bring out more clearly what is happening in these elastic processes, an ordinary helical spring is of some help. This is shown in Fig. 17. As more and more load is attached to the lower end of the spring it elongates more and more and again follows Hooke's law that "Strain is proportional to Stress."

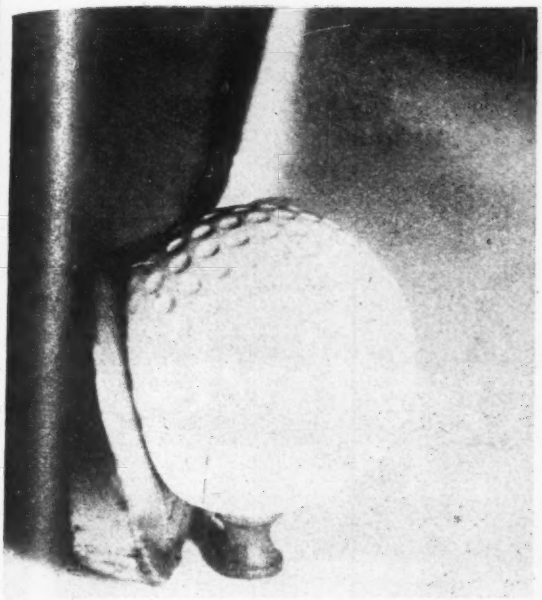


Fig. 18. **A golf Ball is compressed tremendously when struck by** the Head **of a golf Club.**
(Courtesy H. E. Edgerton, M.I.T.)

It is on this principle that we can use an ordinary helical pring for weighing matter or use a spring dynamometer n Fig. 16.

Here one can visualize the adjacent turns in the helix as eing layers of atoms which are pulled apart when the load s applied, but return to normal positions on removal of he force. The interatomic forces in a steel wire when tretched behave in a fashion analogous to the come-and-go etween adjacent turns of the spring. The relation between he force applied to stretch the spring and the actual elongation for that force is called the force constant of the pring. $F/d =$ **force constant.**

The spring may also be used in allowing a weight to be ttached to its lower end and set into linear vibrations up nd down. When it is vibrating in this fashion the period s,—$T = 2\pi\sqrt{M/(F/d)}$ where M is the mass attached to he spring and F/d the force constant.

Furthermore, the spring may have a torque applied to its ower end and the twist will be directly proportional to the orque applied. The torque constant of the spring will be $T_0 = T/\phi$ or the torque per radian where ϕ is measured n radians. As the twist is produced in the spring one turn moves around a little farther than the one next to it and hat is just the way we picture the different layers of atoms o shift over one another a little as a steel rod is twisted n a torsion lathe. Not only will the spring vibrate up and down as just shown, but if the suspended mass in Fig. 17 is given a twist of 5° to 10° and then released it will continue to oscillate with rotational vibrations in which the period $T = 2\pi\sqrt{I/(Q_0/\phi)}$. In this equation I is the moment of inertia of the mass, which is equal to $1/2\ Mr^2$ and Q_0/ϕ is the torque constant just mentioned. This equation will be seen to correspond to the equation for the coefficient of rigidity obtained by the oscillation method.

RESILIENCE.

The resilience of a substance may be defined as the work done per unit volume in straining a substance to its elastic limit. The work per unit volume is equal to one half of the product of the limiting stress, P_{max}, and the limiting strain, D_{max}, according to the equation:—

$$\text{Work} = \frac{P_{max} \times D_{max}}{2}$$

This is graphically represented by the area under the straight line in Fig. 15.

The resilience of a substance is a measure of its strength to withstand a sudden blow, as for example, when a hammer strikes a steel bar and all of the kinetic energy of the hammer is used in bending the steel bar. A body subjected to repeated blows should be made of highly resilient material. Fig. 18 shows how the blow from a golf club compresses the golf ball until all of the kinetic energy of the club has been utilized in compression of the golf ball: The elastic return of the ball to its original shape then drives the ball out on its flight. The golf ball must be made of a highly resilient material in order to withstand the rough treatment accorded it. Fig. 19 has caught the ball in the process of releasing the strain to which it was subjected when struck. This release has sent the ball forward and actually away from the head of the club, although the head of the driver is following through.

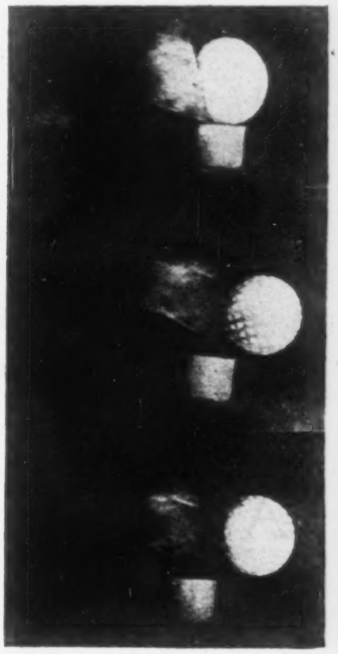


Fig. 19. The golf Ball has recovered its original Form before the Club has cleared the Tee.
(Courtesy H. E. Edgerton, M.I.T.)

These elastic properties come into so many of our games, so many of which are played with balls in one form or another. One could go on indefinitely in giving one example after another where, whether we are conscious of it or not, the elastic properties play an important role in our happiness and comfort. We need only to think of the springs under our automobiles, the elastic properties of the rubber and of the air in the tires on which the automobiles roll, to say nothing of the springs and mattresses in our beds, to realize how much we are indebted to the little man who knew his Latin and some other things and could say, "Ut tensio sic vis." Elasticity is highly important to our everyday life!

WORK! FIGHT! GIVE!
MAKE DEMOCRACY LIVE!

Fuel-Saving
Starts With
CONTROL

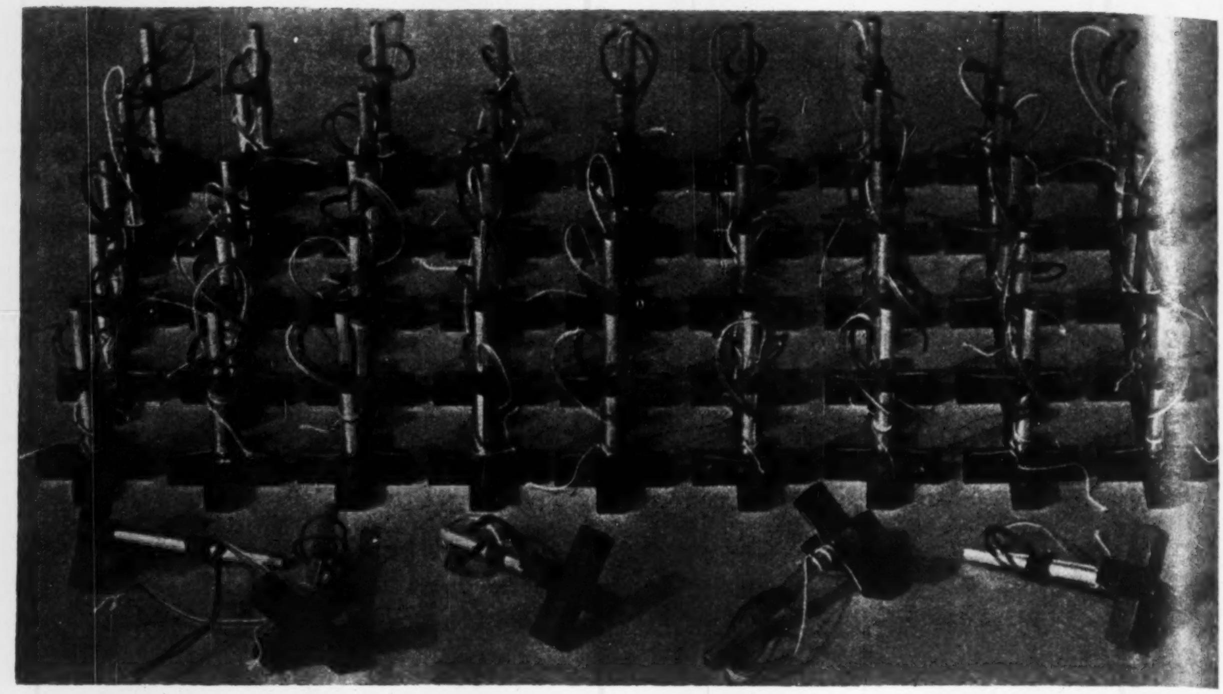


Fig. 1. Detectors used in author's experiments.

A New Method of Determining Fluid-current Direction and Making Circulation Surveys

By **LESTER S. O'BANNON**, Research Engineer, Kentucky Agricultural Experiment Station, Lexington, Ky.

THE METHOD described here was used to measure the direction of air currents in a room which, at the time of the readings, was not accessible for direct observations. This method has other uses (some mentioned below). It involves the use of a primary instrument or "detector" of simple design and inexpensive construction (see Figs. 1 and 2).

The principle of this primary instrument is shown in Fig. 2. AB is a tube having a cross-section and length suitable for a given application. An electric heater surrounds the tube midway between the ends. T_1 and T_2 are the "hot" and "cold" junctions of a thermocouple.

If the tube is placed in a stream of air, or other fluid, such that the direction of flow is normal to the axis of the tube, as indicated by arrow C or D, there will be no flow through the tube. T_1 and T_2 will have the same temperature and the galvanometer will read zero. However, if the direction of the current is at an angle to the axis of the tube, some air will flow through the tube, say from A to B, as indicated by arrow E. In this case the temperature of T_1 will be the same (or nearly the same, depending upon the influence of the heater) as the temperature of the surrounding air, whereas T_2 will have a temperature somewhat higher than T_1, depending upon the amount of heat the air flowing through the tube receives from the heater. The pointer of the galvanometer will therefore be deflected from its zero position in a direction, say, to the right. If the flow is in the opposite direction, the deflection will be to the left.

If now the tube is rotated or displaced from its normal position by some mechanical means by an amount such that the galvanometer again reads zero, the angular displacement of the tube will then indicate the direction of the plane of the current with respect to the initial position of the tube.

It will be observed that calibration of the electrical characteristics of the instrument is not necessary. The exact quantity and source of heat (or cold) applied between the ends of the tubes are immaterial. It is essential only that the general aspects of the assembly be symmetrical with respect to the mi point of the tube.

The instrument may be used in wate air or other fluid at high or low temperature. It may be constructed as smal or as large as a particular applicatio requires. The indicated direction of th current is not affected by the velocity density or other properties of the flui

To suit a given application, any instrument commonly used with thermocouples as an indicating, recording o automatic-control device may be substituted in place of the galvanometer. Th principle, however, is not restricted t thermocouples. For some purposes, direct-expansion or some other type o temperature-sensitive element may b employed. Electrical resistors used in

Continued on page 77

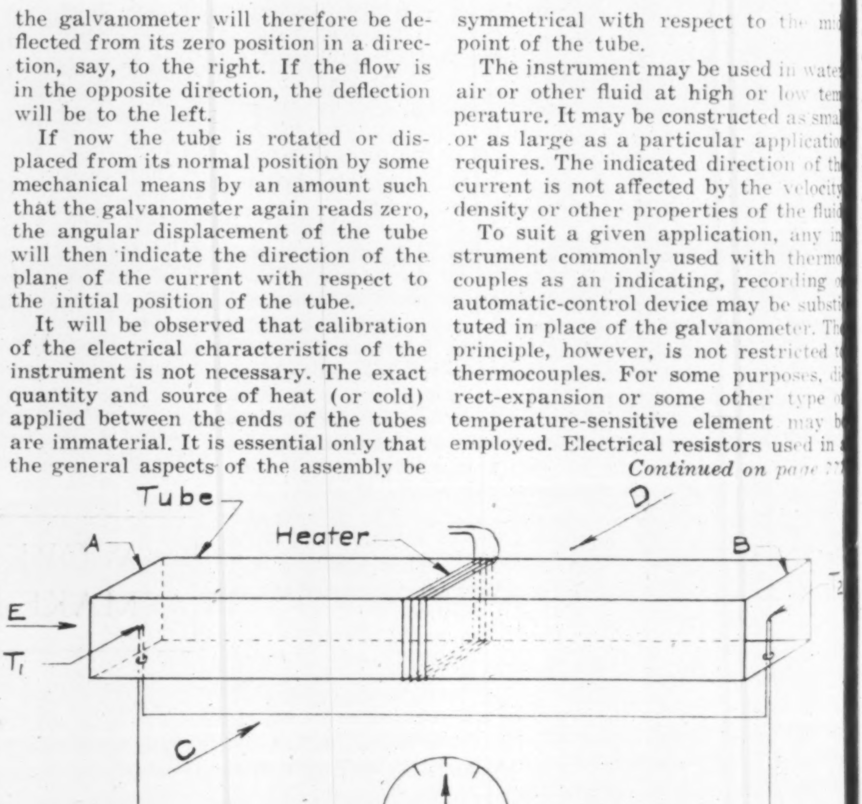


Fig. 2. Schematic diagram of new method.

Two Easily-constructed 0.002″ Micromanometers

By E. R. KLINGE*, P. H. SCHWEITZER, and F. C. STEWART†
The Pennsylvania State College

MOST experimental air-flow measurements are made by means of a pressure drop across an orifice. Under many circumstances this pressure drop must be six inches of water or less. In air measurements to an internal-combustion engine, even six inches of water pressure drop causes an undesirable restriction as it constitutes about 2% of the total pressure available. The micromanometers herein described can measure pressures of 0.200″ of water to an accuracy of ±1% because of their ability to read to ±0.001″.

The single-pressure manometer is sketched in Fig. 1. (A photograph of an earlier model is shown in Fig. 2.) Its simplicity makes it easy for any laboratory to build its own precision manometers. One leg of the manometer is exposed to atmospheric pressure while the other leg is exposed to the pressure to be measured. If the pressure drop across an orifice is being measured, one side of the orifice must be at atmospheric pressure in this case. The diameter of the manometer legs is made large enough to avoid any capillary effects. Both legs must have equal and uniform diameters. The liquid level is determined by electrical contact with the dial gage pointer at the center of one leg. As Fig. 1 shows, a circuit is completed through a small neon lamp when the dial gage pointer makes contact on the liquid surface. This point can be read to ±0.0005″ on the dial gage. Since the pressure difference being measured is twice the elevation change of the manometer leg being measured, the reading accuracy is ±0.001″. It will be noted that the dial gage is mounted so that the stem spring forces the stem upward against the adjusting screw. The liquid ordinarily used is water, a very small amount of impurity being sufficient to make it a conductor.

The measuring procedure is as follows: First the zero setting of the dial gage is determined with both manometer legs opened to the atmosphere. A three-way cock, on the pressure connection leading to the atmosphere and to the test pressure, may be used. With atmospheric pressure on both sides, the point is screwed down until the neon light lights up *on the make.* The dial is set to read zero at that hand position. Then the manometer is brought in connection with the test pressure. The point is raised until the light goes out and then lowered again until contact is made. The difference in height is read from the dial.

Pressure differences of greater than twice the dial gage travel need to be taken care of by spacer blocks on the gage mounting post. The instrument shown in Fig. 2 has a 1″ travel dial gage to minimize the inconvenience of spacer blocks.

Figs. 3 and 4 show what is called the differential micromanometer. The manometer leg on which the measurement of level is made need not be exposed to atmosphere in this case. This makes it possible to measure a pressure differential when neither pressure is atmospheric. Other than the diaphragm added to make this possible, the instrument does not differ from the one previously described.

The chief advantages of these micromanometers lie in their accuracy, obtained with little complication or expense. When using a conventional inclinometer for measuring pressure drop across an air-flow orifice, the orifice size needs to be changed frequently over the range of air flows in order to avoid pressure drops too small to be read accurately. With the accuracy of these micromanometers, changing orifices becomes unnecessary because even the extremely small pressure drops obtained by the largest orifice can be measured accurately. Also, the size of the instrument is small compared to the bulky inclinometer.

The use of these manometers is limited in certain respects. The limitations should be observed and they are listed below:

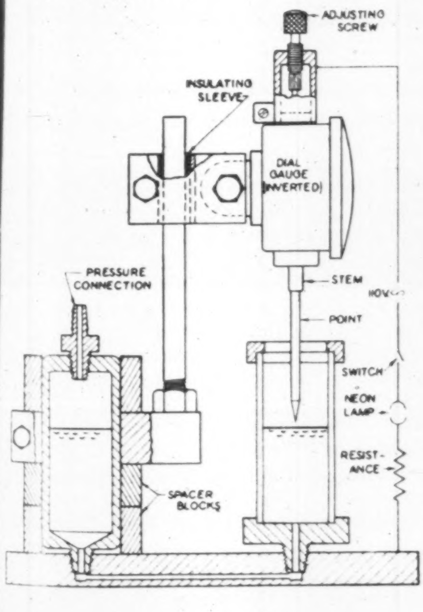
(1) The instrument cannot readily be made direct-reading (e.g. pounds of air per hour). However, substitution into alignment charts is a relatively simple process.

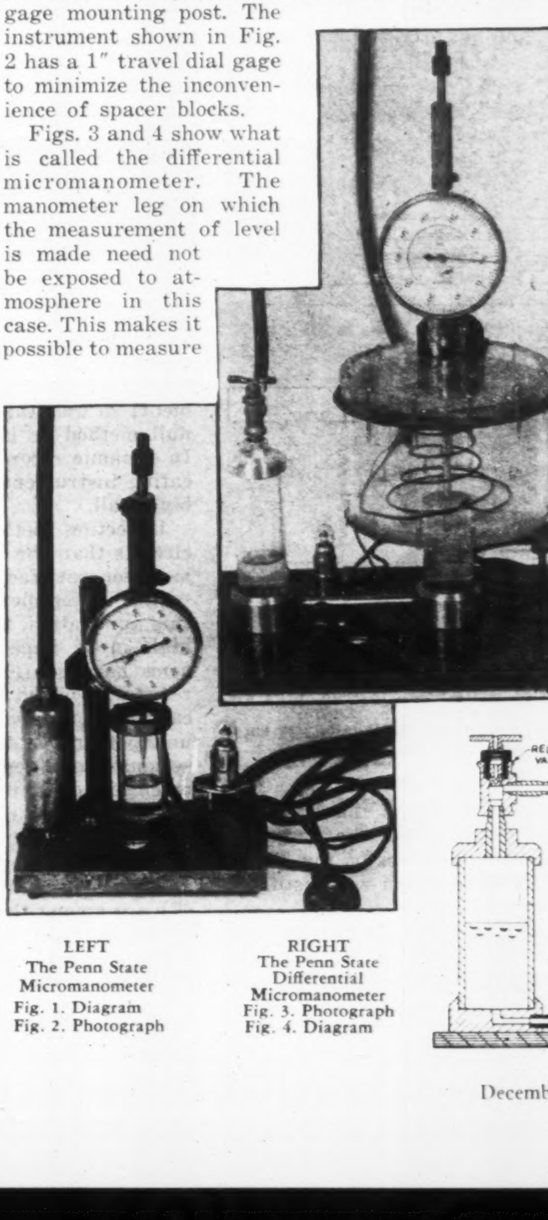
(2) There is no way to introduce atmospheric temperature and pressure corrections into the reading. Alignment charts, again are the answer.

(3) Even with mercury as liquid, the accuracy of the micromanometer is frequently higher than required.

(4) With fluctuating pressure, even if the fluctuations are very small, the measurement becomes inaccurate as the contacting pointer records the highest level rather than any kind of average.

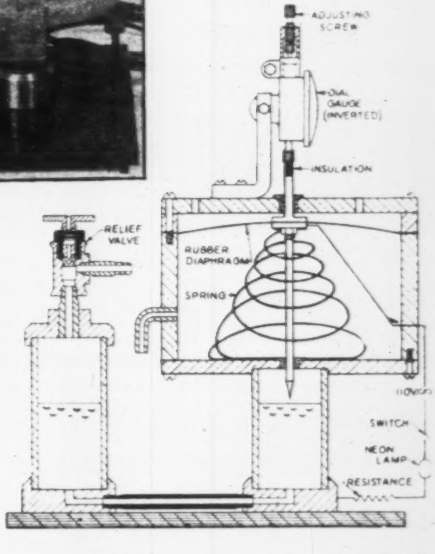
(5) The cross-section of the two manometer legs must be exactly equal and must stay equal.





LEFT
The Penn State Micromanometer
Fig. 1. Diagram
Fig. 2. Photograph

RIGHT
The Penn State Differential Micromanometer
Fig. 3. Photograph
Fig. 4. Diagram



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*Now with Continental Motors Corp.
†Deceased.

ELECTRIC GAGING METHODS for Strain, Movement, Pressure and Vibration

By **HOWARD C. ROBERTS**, Research Staff, Association of American Railroads, Chicago, Ill.

V. GAGING METHODS BASED ON VARIATIONS OF RESISTANCE

(Continued)

§6. ELECTRIC CIRCUITS.

4. Deflection Bridge Circuits

Any of the commonly-used bridge or balanced circuits can be used either in null methods or in deflection methods. No electrical changes are required to convert such a circuit from one method to the other, although a change in mode of operation must be made.

The circuit of Fig. 87 may be taken as an example. When it is used in a null method (as described in Section 2) the indicating instrument serves only to indicate the balance condition of the circuit. The actual measurement (which in electric gaging practice is a measurement of the difference of two resistances) is made in terms of the change which must be made in one of the calibrated arms of the bridge circuit in order to restore the balance which was disturbed by the phenomenon being measured.

The same circuit may be used in a deflection method; and must be so used for dynamic measurements. In a deflection method, the deflections of the instrument indicate by their extent the amount of the change in resistance, while no change is made in the adjustment of the bridge circuit after its initial adjustment.

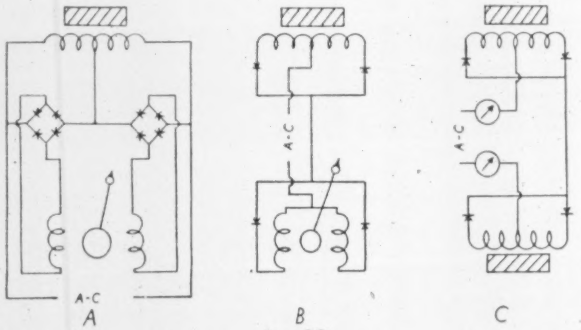

Fig. 50

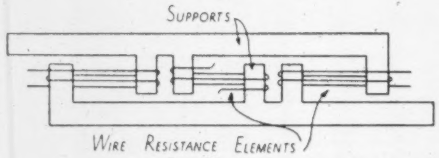

Fig. 73

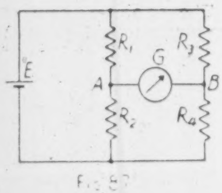

Fig. 87

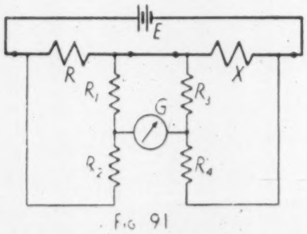

Fig 91

These figures, which Mr. Roberts refers to in this instalment, are reprinted for the convenience of our readers.

Reminder.—Mr. Roberts is preparing the forthcoming articles of his serial, which will describe "Recording Devices." Manufacturers and other persons having information on little-known instruments (or on novel gaging applications of well-known instruments) are cordially invited to communicate directly with him. Address:

H. C. Roberts, Association of American Railroads, 59 East Van Buren Street, Chicago 5, Illinois.

The action of the circuit may be understood by study of Fig. 87. It must be assumed that the applied potential E remains constant, and that the indicating instrument G experiences a deflection always proportional to the potential difference between its terminals while not actually allowing any current to flow. It is also assumed that R_1, R_2, and R_3 are fixed resistance elements (after the initial adjustment) and that R_4 is the variable-resistance gaging element. Then when $R_4 = R_3$ and $R_1 = R_2$, the relation

$$R_1/R_2 = R_3/R_4$$

is satisfied, and no potential will appear across G, so that no deflection will occur. But for any other value of R_4 a potential difference will appear across G and a deflection will result. This potential difference, ΔE,

$$\Delta E = E[R_2/(R_1 + R_2) - R_4/(R_3 + R_4)]$$

Examination of this relation discloses that when all four arms of the bridge are made equal, for small changes in R_4 the potential across G is nearly equal to one-half the percentage change in R_4 multiplied by the exciting potential.

In practice, the variation in R_4 with variable-resistance gaging elements is usually small; the resultant output potentials are never large, so that departure from linearity from this source is negligible. It is not difficult to maintain the exciting potential constant within reasonable limits of accuracy. The remaining requirement—that the indicating instrument allow no current to flow—is ordinarily only approximately fulfilled. Instruments are available which can provide full-scale deflection with currents of only a few microamperes, and yet are of robust construction. Such an instrument, in a typical resistance strain gaging circuit (one which employs commercial wire-type strain gages) will draw less than 1% of the exciting current under all operating conditions, and thus will cause only negligible departures from the theoretical conditions.

The mathematical relations given to express the actual behavior of the bridge circuit of Fig. 87 apply rigorously only if no current at all flows through the indicating instrument; so that this condition is perfectly satisfied only in a null method or if a zero-current instrument is employed. In dynamic recording, where an amplifier replaces the indicating instrument, the current drawn can be made negligibly small.

Deflection methods can be employed with other bridge circuits than the Wheatstone; the Kelvin circuit of Fig. 91 has been satisfactorily used as a deflection bridge circuit, with an amplifier replacing the indicating instrument. In this application, the use of an amplifier with its extremely high input impedance makes it possible to employ ratio arms having high resistance; the small variations in lead resistance which may occur (especially if these leads are carried to a moving part through slip-rings) then become unimportant. In the normal Wheatstone bridge, there is a serious loss in sensitivity if two of the ratio arms are very much higher in resistance than the other two.

Certain mechanical forms of pick-ups are especially well suited to deflection bridge applications. Resistance-ratio pick-ups, such as the Carlson strainmeter (see Fig. 73) and the Peters-McCollum carbon-pile telemeter (see Fig. 67) are among them. Moving-contact pick-ups of dual slide-wire construction,[200] with all four arms of a Wheatstone bridge circuit incorporated in the pick-up head, and with all of the arms changed by the incident movement, provide

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(200) R. Elsaesser. Messen von Schwingungen und Drehmomenten mittels des Oszillographen. *Zeitschrift Verein deutsches Ingenieure*, Vol. 68, 1924, pages 485-491.

erhaps the best example of this sort of mechanical assemly. Two such pick-ups, for rotatory and translatory moveents, are diagrammed in Fig. 94. In principle, they are ke that of Fig. 64A; their construction however is speially suited to their application in deflection-bridge circuits. hese particular pick-ups were first constructed for the easurement of torques and linear oscillations in heavy achinery, and their output was recorded by the magnetic scillograph.

5. *Alternating-current Bridge Circuits.*

Either of the two basic forms of bridge circuit already escribed, and shown in diagram in Fig. 87 and Fig. 91, an be excited by alternating current if suitable precautions re taken. These precautions are made necessary because n most instances the components incorporated in the arms f the bridge circuit are not purely resistive in their nature; hey have a reactive component as well. If a-c. excitation is sed, the indicating instrument must of course be sensitive o alternating current.

Although the actual components employed in the constructon of the bridge circuit may be carefully selected with inimum reactive components, it is inevitable that after hey are installed there will be certain capacitances present hich will act to unbalance the circuit. If the balance is to e perfect, there must be facilities for providing resistive, nductive, and capacitive balances; in general the three alancing processes must be independently conducted. After the initial balancing process is completed, it usually is satisfactory to leave the settings unchanged during operation; there will be, of course, minor variations in inductance and capacitance accompanying the resistance variation, but these effects are ordinarily small and can be safely neglected. It is not safe to neglect the inductive and capacitive balances in the initial adjustment.

In any bridge circuit an electrical capacitance appears between the conducting elements of the circuit and their surroundings. Capacitance to ground is usually greater than any other of the stray capacitive and inductive effects. If the circuit is excited by alternating current, the reactances of these capacitances appear effectively in parallel with certain of the resistive elements; since the magnitude of the reactances decreases with the excitation frequency the balance of the circuit will be more seriously affected as the excitation frequency is made higher. The effect is especially large— and especially troublesome— when a single variable-resistance gaging element is installed at the end of a long cable connection. These stray capacitances must be balanced out for satisfactory operation, and provision must be built into the equipment for this adjustment. Symmetrical mechanical construction within the equipment minimizes these difficulties.

The most widely-used circuit for this stray-capacitance compensation is the Wagner ground.[201] This device is a simple tapped resistance element installed across the detector arms of the circuit, with the tap connected to ground. The position of the tap is adjusted until the potential at the junction of the ratio arms equals ground potential; the four-armed circuit composed of the stray capacitances and the two resistive arms of the Wagner ground is then balanced.

A similar circuit, which can accomplish this, or can introduce a constant phase shift for control purposes, is shown in Fig. 95; the constants are those used for excitation by 60-cycle line current in resistance thermometry.[202]

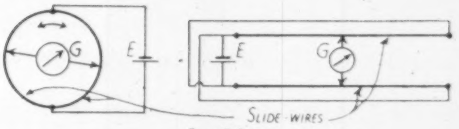

Fig 94

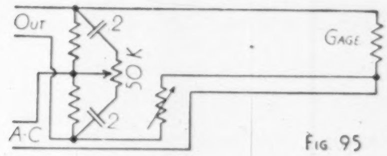

Fig 95

In resistance bridge circuits, inductive reactance seldom introduces difficulties; resistive elements are constructed to have low time constants (small inductive components) and resistance-type gaging elements are usually designed to minimize inductive hum pick-up, which also implies small time constants. Small inductance values mean low impedances, increasing with the frequency of excitation. The inductive reactances appear in series with the resistances, and are nearly always quite low in comparison with them, so that they cause little change in the effective impedance of the element. Stray inductances (inductances between conductors) are less likely to occur, or, if they do occur, to cause trouble, than stray capacitances. In many installations it is possible to install resistance-ratio gaging elements, or to employ compensating elements, thus balancing out the inductive components.

For use in extremely strong a-c. fields, it has occasionally been found necessary to employ special means of compensation with resistance-type gages. Even the wire-type resistance strain gage, with its low impedance, has been found to possess sufficient residual inductance to introduce difficulties in operation. In a study of the forces and rates of application in resistance welding machines, such wire gages have picked up sufficient 60-cycle hum to disturb the measuring equipment severely.[203] It was found necessary to wind special forms of the gages in order to eliminate the difficulty. This is an unusual application, because of the high currents involved and their close proximity to the measuring circuits; it is of interest because it illustrates the fact that it is possible to operate electric gaging equipment even under severe conditions.

The alternating-current bridge circuit offers certain advantages in operation over the direct-current type. When amplification of the bridge output is necessary, it is easier to accomplish with the a-c. bridge circuit than with the d-c. form. The operational difficulties introduced by a-c. excitation are not great.

In field or industrial applications, mechanical and electrical disturbances are to be expected. Isolation from both can be provided in the laboratory, but in the field it is necessary to counteract these disturbances by equipment design. It is possible to design the bridge circuit for excitation at a particular frequency, and to make the indicating or recording instrument sensitive to that frequency only. The presence of disturbing electrical phenomena of other frequencies then will cause only minor effects in the output of the gaging circuit. Electrolytic, contact, thermal, or other slowly-varying (or steady) potentials will cause no experimental difficulties. The source of excitation energy may be any that is convenient. The indicating or recording device may be a vibration galvanometer or any other instrument which is sensitive to the excitation frequency only. Instruments sensitive to all frequencies uniformly will not satisfy this requirement unless filters are used to remove all except the excitation frequency.

If amplifiers are employed, either to increase the sensitivity of the system or to increase the output for actuating a high-frequency recording device, certain special circuits are available which will provide the desired action.

In any a-c. bridge circuit, the output increases with the departure from balance; unlike d-c. bridge circuits, direction of unbalance is not clearly indicated by polarity of

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(201) Keith Henney. Radio Engineering Handbook. Section 7. McGraw-Hill, 1941, 945 pages.

(202) M. Benedict. Use of the Alternating-current Bridge in Laboratory Temperature Control. *Review of Scientific Instruments*, Vol. 8, 1937, pages 252-254.

(203) W. F. Hess and R. A. Wyant. A Method of Studying the Effects of Friction and Inertia in Resistance Welding Machines. *Welding Journal*, Vol. 19, 1940, pages 433s-440s.

output current or potential. The phase of the output potential of an a-c. bridge circuit is changed 180° by passing through the balance point, however, so that by the use of phase-sensitive rectifiers both magnitude and direction of unbalance may be indicated. Such rectifying circuits often include amplification to increase sensitivity.

Mechanical methods are available for accomplishing the same result. If a secohmmeter (a mechanical double-commutator arrangement which converts direct to alternating current, and then reconverts the alternating to direct current) is employed, the required phase-discrimination is provided. The secohmmeter may be used either with or without amplification. If amplifiers are used, they are placed between the two commutating sections of the device. Or, if a vibration galvanometer is used as an indicating instrument, with an interrupted source of light of the same frequency and phase as the excitation frequency (such as may be provided by a neon glow lamp) the galvanometer mirror will be illuminated only during a part of each oscillation, and instead of a continuous band of light appearing on its scale a short band or spot will result. The position of this spot will indicate the phase position of the mirror and the phase of the output current of the bridge circuit.

6. Potentiometer Circuits.

The basic principle of the potentiometer is that of balancing an unknown potential against a known one; it is analogous to the bridge principle, which balances unknown resistances against known ones.

The application of the potentiometer to electric gaging depends upon the fact that if a constant current is maintained through a resistance element, or a constant potential maintained across the gaging element and a large constant resistance, the potential drop across the gaging element will vary in the same manner as does the resistance. If this potential is measured with a potentiometer or other device, the indications of the instrument will follow the changes in the resistance values and therefore the magnitude being measured. When a slide-wire or other moving-contact form of gaging element is used, the potentiometer may effectively be applied as in the circuit of Fig. 80. For any other application which requires an instrument that measures potential without drawing current from the circuit (as with the electrolytic type of gaging element, or with any circuit of extremely high impedance in which only small currents flow) the potentiometer is suitable.

A particular application of interest is in connection with the volt-thermometer—a device used to measure the current flowing in a thermosensitive bridge circuit. The potential drop across a thermosensitive element in series with the source of energy indicates the current flowing. The device is more sensitive than a shunted ammeter, because the resistance of the thermosensitive element increases as more current flows.[204] In this circuit it is convenient to employ an instrument drawing no current, so that all the bridge current flows through the thermosensitive element.

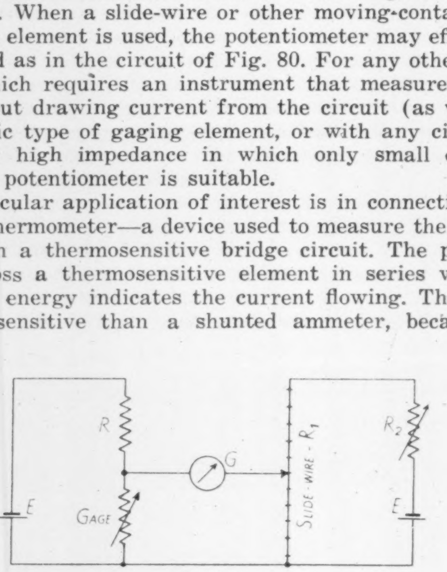

Fig 96

A simple circuit illustrating the potentiometer principle is shown in Fig. 96. Two separate sources of electric energy are used. The current through a resistance-type gage is maintained essentially constant by placing in series with it a high resistance *R;* the total resistance of *R* and the gage in series changes only slightly with the operating variations in the gage. Since the current through the gage is nearly constant, the potential at point *A* will vary whenever the resistance of the gage is altered by the incidence of the unknown phenomenon. At the right side of the diagram is shown another source of electric energy (another battery) connected through a variable resistance R_2 to a graduated resistance unit R_1. Resistance R_2 is adjusted until the current flowing is sufficient to provide a known potential drop across each unit length of the graduated resistance unit R_1. This graduated resistance element may therefore be calibrated in terms of potential, and if the moving contact on R_1 is adjusted so that no galvanometer deflection occurs, the potential at *A* must equal that at *B*, and the potential across the gage can be read on the graduated scale of R_1.[205] It is customary to provide a standard cell, of known and constant potential, by which the adjustment of the potentiometer circuit can be checked at any time. In some instruments, especially portable ones, a thermo-cell* replaces the standard cell. While less accurate than the standard cell, the thermo-cell has the advantages of small size, light weight, robustness and freedom from freezing damage. Since no current flows in the galvanometer circuit at balance, an indicating instrument of high current sensitivity can be employed (shunted for preliminary adjustment). High sensitivity is thus made possible. The accuracy of the device depends upon the accuracy of graduation of the resistance unit and the accuracy of the standard cell; the sensitivity of the indicating instrument is a factor of moderate importance.

The utmost sensitivity and accuracy in electric gaging applications are obtained when the potentiometer is employed to measure the output of a bridge circuit. The maximum potential to be measured then is small, and the potentiometer can measure it to one part in 10,000, or even better.

The potentiometer principle is most effectively employed in null methods, although instruments known as deflection potentiometers are sometimes employed when measurements are required at close intervals, or if continuous indication is desired. The deflection potentiometer, like the deflection bridge circuit, is simply a potentiometer circuit used in a different manner: instead of bringing the potentiometer to balance for each reading, it is brought to balance at the beginning of a series of readings. The deflection of the galvanometer is then used as an indication of changes in the magnitude being measured. Like the deflection bridge circuits, deflection potentiometers sacrifice accuracy to gain speed of operation. The indicating instrument in the deflection potentiometer must be calibrated.

Potentiometer circuits are made in a variety of forms; in all, however, the basic principle is the same—the balancing of an unknown potential against a known one. Some are self-balancing by means of automatic mechanisms. Amplifiers can be used in conjunction with potentiometer circuits, but seldom are, except as adjuncts to the automatic balancing mechanisms.

Either alternating or direct current can be used in potentiometer circuits. The use of alternating current is attended with many experimental difficulties, however, because of the necessity for phase compensation of all portions of the circuit, the use of phase sensitive detectors, and the difficulty of balancing all portions of the circuit to ground.

7. Other Circuits for Resistance-type Gages.

Circuits apparently differing from those described in the preceding sections have been employed with resistance-type gages, but they have in nearly all cases proved on examination to be modifications of the basic types described.

The Kelvin and other current balances have been effec-

Continued on page 755

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[204] R. O. King. The Measurement of Air Flow. *Engineering* (London), Vol. 117, 1924, pages 136-137 and 249-251.

*A thermo-cell is a thermocouple having the characteristic that at a definite temperature above the ambient temperature its potential output decreases to zero and reverses polarity. The current through a small heating coil attached to the thermocouple can be reset accurately to the value at which this reversion occurs.

[205] S. G. Starling. Electricity and Magnetism. Chapter 4. Longmans, Green and Company, 1929, 600 pages.

ELECTRON TUBES—Their Principles and Their Instrumentation Applications

By **ANDREW W. KRAMER, Managing Editor,** *Power Plant Engineering,* **Chicago, Ill.**

XXIV SENSITIVE CONTACTS. ELECTRONIC RELAY CIRCUITS

Sensitive contact applications of the electron tube comprises that broad class of measuring instruments and control devices in which an amplifier tube serves to transfer a measurement signal or a control impulse in amplified form to an electromechanical indicator or relay. Generally, the control impulse is applied between the grid and cathode while the plate current flows through an ammeter or relay coil. When the net voltage between the grid and cathode changes by a sufficient amount, the plate current varies correspondingly to provide a reading on an instrument or to "pull-up" or "drop out" a relay. The tube serves a purpose, of course, only when the initiating voltage is too small to operate the relay or indicating instrument directly, or when it is necessary to operate the relay or instrument without drawing current from the control source. In the measurement or control of extremely small variations in temperature for example, tiny and very delicate thermostats are sometimes used. The delicate contacts on such thermostats must open and close an electric circuit which operates a relay which in turn controls large amounts of power. Even with small voltages, sparking at the contacts of such thermostat elements will in time cause oxidation with consequent high resistance and so finally render the system inoperative. When the restoring forces are small, even with small voltages the contacts may stick together. If, however, the contacts are used merely to close the grid circuit of an amplifier tube, the amount of current flowing will be so small that no sparking of any kind occurs and the contacts will remain operative indefinitely.

In nearly all applications of this kind the electron tube functions as a relay—an extremely sensitive relay. Where high-vacuum tubes are used, the amount of power developed even in the plate circuit is too small to operate a magnetic relay directly, so the first amplifier tube is usually followed by others in cascade. With grid-controlled gas-filled tubes, on the other hand, the situation is different. In these tubes the plate current, as has been shown, is much greater than in high-vacuum tubes and even the smallest thyratrons will pass plate currents of the order of 100 milliamperes, while moderate-size tubes will handle currents from one to ten amperes. Such tubes have a further advantage for certain purposes in that they have a more nearly true trigger action. That is, as the grid potential changes up to a certain value, nothing happens and then a small voltage change will cause the tube to "fire" and the maximum plate current flows. All this has been fully explained in the earlier articles on thyratron action. What is true of the thyratron in this respect is also true of the cold-cathode grid-glow tube. These also have a true trigger action but the plate current is not as great as in the case of the hot-cathode gas-filled tube.

The Grid-glow Electron-tube Micrometer

The simplest and yet one of the most useful applications of the sensitive contact principle in electronic measurement is in the use of the grid-glow tube in the electron-tube micrometer. In some instances in industrial process control it is necessary to make exact measurements of very delicate or very ductile materials which may be deformed or broken by the pressure of the jaws of an ordinary micrometer, and the operator's sense of touch may not be sufficiently sensitive for making exact readings since the material must build up resistance to the micrometer screws.

By arranging a grid-controlled rectifier in such a way that the tube will glow when contact is made between micrometer points and the object being measured, the exact point of contact is easily and accurately determined. In this way extremely accurate micrometer measurements are made without the slightest pressure of the jaws upon the material. Of course, in this case the micrometer is still the actual measuring instrument, the electron tube serving merely in place of our own sense of touch. No contact pressure is required and the tube is more sensitive than any operator's touch.

With some devices of this type it is easily possible to take readings to the nearest 0.00001". The indicating device, however, is sensitive to changes which are very much smaller than those which can be read. By means of recording devices, movement of the micrometer barrel is mechanically magnified so that changes as small as two microinches (two millionths of an inch) can be read. This distance is about one-tenth of the wave length of green light and therefore is equivalent to one-tenth of a fringe in an interferometer. *It is largely due to the electron tube that fine measurements are being made so easily in so many industries, and that the word "microinch" is heard in so many plants where yesterday a "ten-thousandth" was spoken with admiration.

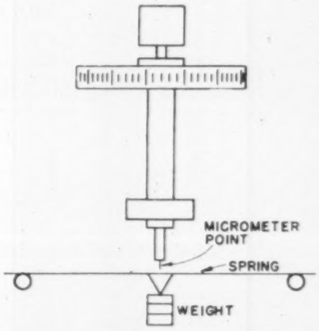

Fig. 204. Arrangement used in testing hereditary hysteresis of instrument springs. The element of spring ribbon is placed across two horizontal pins and loaded with a weight. The deflection is then measured by a micrometer which is so connected to a grid-glow tube that the tube flashes at the instant the micrometer point makes contact with the spring.

Measurement of Creep in Metals

An interesting application of this principle is in the measurement of creep of metals at high temperatures. Those familiar with high-pressure steam plant operation need no introduction to the importance of "creep." With the high sensitivity of measurement just referred to in a typical test, the creep in a certain specimen during the first 20 minutes after applying the load was 0.0097". After heat treatment the creep under the same load conditions was only 0.0013". Thus, instead of requiring days of time, the accurate determination of creep by the electron tube micrometer is obtained in a few minutes of testing.

This type of micrometer has also been used successfully in the measurement of hereditary hysteresis effects in the manufacture of spiral springs for instruments. In this case a short length of spring is placed on two parallel horizontal pins and loaded with a weight as shown in Fig. 204. The deflection of the spring is measured with a micrometer head fitted with a sharp contact point. Contact between the micrometer point and the spring operates a grid glow tube to indicate the point of contact. A large diameter drum and a magnifying lens is attached to the micrometer head to permit accurate readings and a constant tension drive is used to make accurate settings of the micrometer.

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*The interferometer measures minute distances by means of the interference between light waves. This interference manifests itself by a series of dark or colored lines or fringes which are a function of the distance being measured.

Micrometers of the type just described have been developed and used for specialized industrial measurements where extreme accuracy is important, but they are simple to make as is evident from Fig. 205 and any person with a little ingenuity can make one for almost any use where greater than ordinary accuracy is required. Offhand, it might be supposed that the electron tube is superfluous, that the point of contact could be determined by a sensitive voltmeter. True, accurate measurements could be made in this way but the grid-glow tube is so extremely sensitive that no arcing of any kind takes place at the contact points.

In an electron tube micrometer of this kind described by Robert Carson and used in the investigation of instrument springs† an autographic attachment was developed which produced a continuous record of displacements of the test specimen, so that a test could proceed without being disturbed. The grid-glow micrometer was found to be sensitive to displacements of ten microinches with a contact resistance of more than one megohm. (Carson reported attaining an ultimate sensitivity of a tenth of a microinch. —Ed. *Instruments.*)

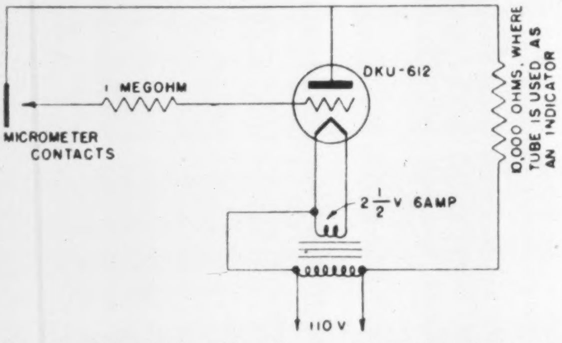

Fig. 205. The circuit used with the electron-tube micrometer.

The same principle employed in the micrometers just described can be used with tubes other than the glow tube. Thyratron tubes lend themselves admirably to this type of application and an electronic relay using thyratrons is described at the end of this article. An electron-tube voltmeter can be used in place of the glow tube and the point of contact noted by the sudden upswing of the plate milliammeter. Circuits using the electron tube voltmeter as the contact indicator have been used to measure the minute deflections of the armature of a loud speaker and in this application movements of 25 microinches of an inch were determined.

Sensitive Contacts in Combination With Other Devices

The sensitive contact principle, of course, is used in a great variety of applications, such as in pressure and temperature control. In other words, whenever slight mechanical movements have to be translated into electrical impulses. Even where the initial effect is produced in other ways, sensitive contacts are often used to convert direct voltages into alternating voltages.

Electron-tube Pyrometers

An interesting example of this type of application is that shown in Fig. 206 which is a schematic diagram of the Brown "Electronik Continuous Balance" Potentiometer Pyrometer. The operating principle of this system utilizes the same "null balance" measuring circuit used in the conventional potentiometer pyrometer but differs in that the balancing operation is continuous and not periodic. The usual galvanometer and its associated mechanisms are replaced by a "continuous balance" unit which electrically amplifies the unbalanced voltage in the measuring circuit to provide the necessary energy to operate a rebalancing motor which repositions the slide-wire contactor and the recording pen and/or indicating pointer.

To secure the electrical amplification of the unbalanced d-c. voltage in the measuring system, the "continuous balance" unit first converts this d-c. unbalance into alternating voltage. This alternating voltage is then amplified by electron-tube amplifiers and used to drive a small reversible 2-phase balancing motor. One phase winding of this motor is supplied from the a-c. line while the other phase winding receives the amplified output of the converter unit. The current from the converter unit will either lag or lead the line current voltage, depending upon whether the temperature is below or above the point of balance. Thus the motor rotates either in one direction or the opposite to re-establish the balance of the slide-wire potentiometer.

The conversion of the direct voltage output of the thermocouple into alternating current is accomplished by a converter unit. This converter is essentially a flat metal reed oscillating between two contacts connected to opposite ends of the primary winding of the input transformer. The vibrating reed is energized by an energizing coil supplied with alternating current. Thus as the vibrating reed moves from one contact to the other, any unbalanced direct voltage will cause direct current to flow first in one direction through one half of the primary winding, then in the opposite direction through the other half of the primary winding. This action generates an alternating flux in the input transformer secondary.

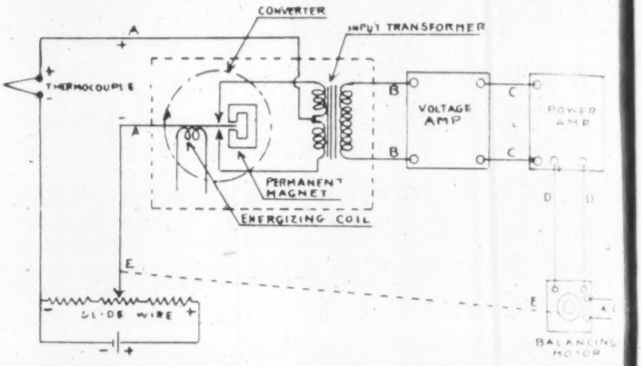

Fig. 206. Schematic diagram of the Brown "Continuous Balance" system.

The action of the converter is related to the a-c. supply voltage by the energizing coil which is excited by a-c. line voltage through a step-down transformer. The reed is polarized by a permanent magnet and is therefore actuated by the energizing coil to oscillate in synchronism with the a-c. supply voltage.

The entire rebalancing action of the converter is based upon the timing relationship between the alternating voltage produced by the converter and the a-c. supply voltage wave. In one case, when the temperature rises above the temperature at which the potentiometer circuit is balanced, the voltage produced by the converter is in phase with the line voltage; in the other case, when the temperature falls below the temperature at which the potentiometer is balanced, the converter voltage is 180° out of phase with the line voltage.

This particular action need not concern us here but what is important here is the principle of converting the extremely weak direct current developed in the potentiometer thermocouple circuit into alternating current by means of the vibrating contacts. The principle itself is not new, since a reversal of it has been used in mechanical rectifiers for a long time, but what is important is that this alternating current could not be utilized if it were not for the electron-tube amplifier. The amplifier is what makes the system possible.

The same balancing effect is accomplished in widely different ways in different control circuits. In some cases, as in the Tagliabue "Celectray" system, the balance is accomplished photoelectrically. In this system a mirror type galvanometer reflects a light beam onto a phototube and the output of the phototube, through an amplifier, controls the rebalancing motor. In the Leeds & Northrup "Speedomax" the unbalance voltage is converted to an alternating voltage by means of a carbon microphone, alternately compressed and released at 60 c.p.s. by a magnetic drive energized from the a-c. supply line. This particular circuit is shown in Fig. 207. In this case the amplified unbalance a-c. voltage controls a thyratron-controlled motor which drives a magneto-tachometer. Depending upon the phase, one or the other of the thyratrons will fire and drive the balancing motor in the proper direction to rebalance the circuit. The tachometer voltage is introduced into the circuit so that the speed of the motor is proportional to the unbalance of the system and its purpose is to avoid overshooting the balance point and causing the system to oscillate and hunt.

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†*Instruments*, Vol. 5, April 1932, pages 89-90; *Electrical Engineering*, Vol 53, February 1934, pages 282-286; ***Instruments***, Vol. 7, June 1934, pages 109-112.

The temperature control devices described in the foregoing paragraphs have been introduced at this point because their performance is based more or less directly upon the opening and closing of circuits by moving contacts. In the Leeds & Northrup instrument just referred to, the carbon microphone provides the contacts, i.e., the variation in contact resistance of the carbon granules.

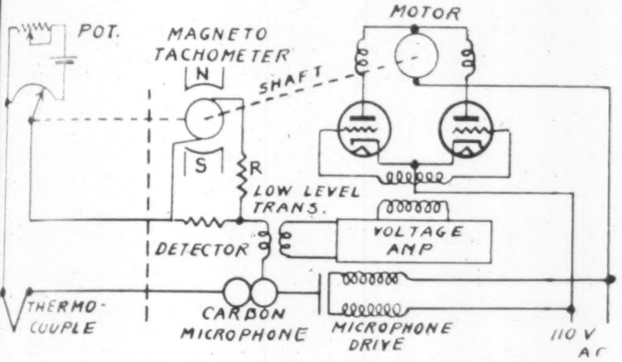

Fig. 207. Circuit of the Leeds & Northrup "Speedomax" in which the unbalance voltage is converted to a.c. by a driven carbon microphone. The speed of the balancing motor is regulated by the action of the magneto-tachometer which generates a voltage in opposition to the unbalance voltage.

Flame Failure Control

A variation of the sensitive contact principle is in the flame failure control system for furnaces. Systems of this type are the Brown Instrument Co.'s "Protectoglo" and the Wheelco Instrument Co.'s "Flame-otrol." In both of these instruments the sensitive contact is a flame—that is, they make use of the conducting property of a flame.

A flame—any flame, regardless of how it is produced—is nothing more nor less than a region of intense ionization in which the ions are recombining and producing visible radiation. Now, it has been shown that any region in which free ions are present is a conductor of electricity. Thus, if a potential is established across any portion of a flame, an electric current will flow across that portion.

The process of combustion is one which continuously splits neutral atoms and molecules into positive and negative ions and it is the recombination of these ions immediately afterwards that produces the effect which we call a flame. The instant the process of combustion stops, the ions produced immediately recombine, the flame "goes out" and the region which it occupied almost instantly becomes non-conducting.

Thus, it is evident that if an electric circuit containing a current-indicating instrument and a source of electromotive force such as a battery is arranged so that the flame becomes a part of the circuit, current will flow as long as the flame continues to exist, but the instant it goes out, the current will cease.

In this case a microammeter is needed as the current-measuring instrument. A microammeter is necessary because the resistance of a flame is usually very high and, even with a high-voltage battery, the current in the circuit will be very small. The resistance of an ordinary flame may be anywhere between 1.5 and 150 megohms. Thus, even with the lower value and a battery of 1000-volt potential, the current would be only 1000 ÷ 1,500,000 or 1/1500 amp. At the upper value the current would be only 1/150,000 of an ampere.

This is where the electron tube can demonstrate its usefulness and it does. By making the path through the flame part of the grid circuit of an amplifier tube, minute changes in current through the flame can be made to control a relatively powerful plate current which in turn can actuate relays and operate other control equipment. In the case of one of the commercial forms of this protective system, as long as the resistance of the flame is anything between 1.5 and 150 megohms, the control system serves to keep the gas flowing. If the resistance exceeds 150 megohms, there would be no flame and the control device would automatically shut off the gas. The actual manner in which this control is accomplished is different in the Brown and Wheelco systems but fundamentally the principle of using the flame as a conductor is the same.

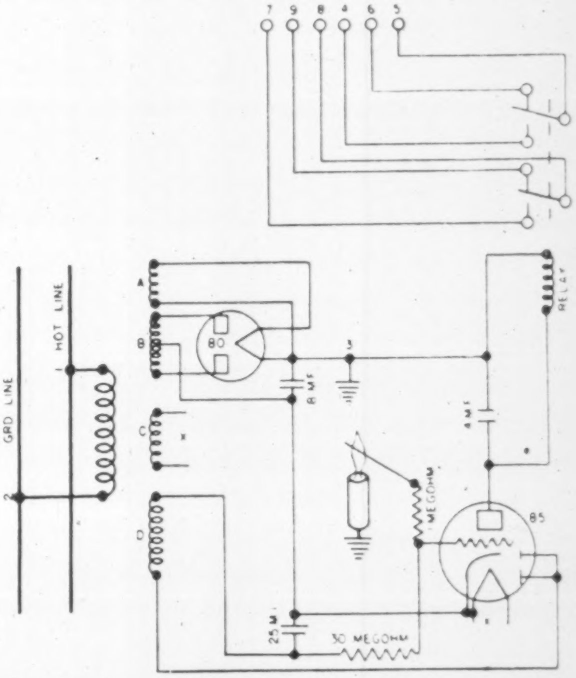

Fig. 208. Schematic diagram of the Brown "Protectoglo" System.

The Brown Protectoglo system shown in Fig. 208 in its simplest form merely shuts off the gas supply and it remains shut off until it is relighted manually. In an extension of this system, however, after the first failure of the flame, an automatic re-ignition system comes into action and attempts to re-establish the flame.

Two electron tubes form the heart of this system. One, an 80 type full-wave rectifier supplies high-voltage direct current to the plate circuit or the 85 double-diode triode. A single transformer with four separate secondary windings supplies current for the filament and heater circuits of the 80 and 85 tubes respectively, plate current for the 85, and a biasing voltage for the grid circuit of the 85. The grid bias voltage is rectified by the diode portion of the 85 tube.

There is one feature about the Brown circuit that is quite unorthodox. The positive side of the plate circuit is grounded. This is quite unusual—usually the negative side is grounded. The purpose of this ground, however, is to place a positive potential on the grid of the 85 tube when the flame is lighted. This positive potential which is derived from a secondary winding normally opposes the negative potential supplied by the bias winding and since it is of a higher value the grid carries a positive charge. Under this condition, plate current flows and a relay is energized, keeping the valve in the gas supply line open.

Continued on page 756

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200 OHMS
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WATTS; NOMINAL
MFG. CO. CHICAGO, U. S. A.

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Vol. III, No. 12 M. F. Behar, Editor December 1944

Workers' Ingenuity Speeds AAF Control-system Bearing Repair

By Colonel **WILLIAM TURNBULL, Commanding Officer, San Bernardino Air Technical Service Command**

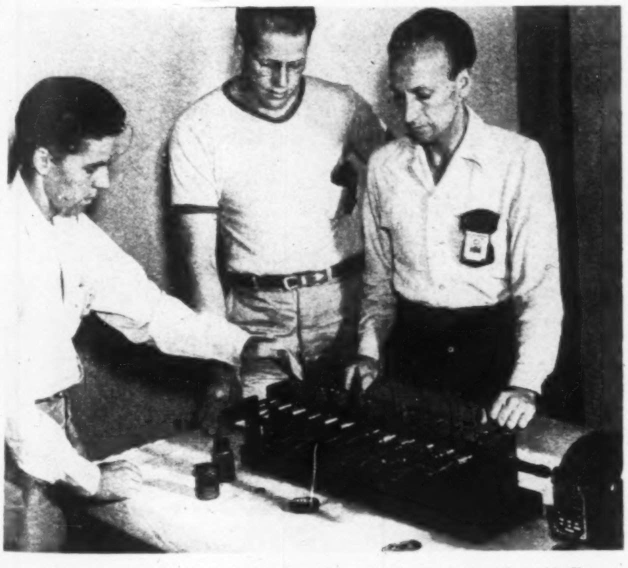
DISSATISFIED with the slow and not always accurate hand method employed in lapping bearing races, three Air Technical Service Command workers have devised a lapping and polishing machine which does its job in $\frac{1}{24}$th of the time previously required and which has increased salvage of used bearings from approximately 30 percent to better than 70 percent.

They are Lester W. Littleton, Howard V. Staniforth and Russell E. Christianson, who work on repair of vital aerial automatic-control equipment in the bombsight branch at San Bernardino (Calif.) Air Technical Service Command, one of a dozen continental supply and maintenance centers set up by ATSC.

The new machine, in addition to saving quantities of critical material, turns out smoother and more evenly polished bearings and effects a substantial saving in precious man-hours.

While the machine thus far has been used only in automatic flight control equipment bearing repair, its inventors believe that it can be used profitably in any industry where the repair of self-aligning bearings up to 1½" is a factor.

Air Technical Service Command, headed by Lieut. Gen. William S. Knudsen, with Maj. Bennett E. Meyers as deputy director, is charged with engineering, procurement, supply and maintenance of AAF planes and equipment.



Three Air Technical Service Command workers, Russell E. Christianson, Howard V. Staniforth and Lester W. Littleton (left to right) are shown with their lapping and polishing machine for bearing races. For their development of the device, which replaces a much slower hand method, they were awarded $250 by the San Bernardino (Calif.) Air Technical Service Command committee on civilian awards.

The three inventive San Bernardino workers received for their ingenuity, in addition to the satisfaction of making an important contribution to the war, a cash award of $250.

Bearings of the self-aligning type tend to become unserviceable by reason of pits and scratches in the race surface, or inner surface of the outer ring of the bearing, making it necessary previously to condemn many bearings which now may be salvaged through use of the new device.

Formerly a collet, which held the bearing race, was attached to and revolved by a vibration motor. A lead shoe, held inside the race by hand, was used with a fine abrasive to polish the surface. This method resulted in expenditure of about an hour per bearing race, without any assurance of complete accuracy.

The machine developed by the three men accommodates twelve races at a time, driven at a set speed on shafts protruding through the front of a gear box. The laps, formerly held by hand, are now attached in pairs to springs which in turn are clipped to a rocker arm, operated by a cam arrangement.

The laps, forced apart on the tips of their v-shaped spring, exert outward pressure on the race when inserted into the slowly-revolving bearing ring. Being slightly convex in shape and with the apex of their spring being moved up and down by the rocker arm, they provide an even polish to the concave surface of the race.

The machine in use now was developed from an experimental model which accommodated two races at a time. Where it formerly took one man approximately an hour to polish and refinish one race under the old method, the new permits of two men performing the operation on twelve races in approximately 30 minutes.

Electrical Computing Gunsight

DIRECTING streams of .50-calibre bullets from top-speeding U.S. Army Air Forces bombers at the enemy's fastest planes with an accuracy approaching that of stationary guns firing at stationary targets, an electrical automatic-computing gunsight has been announced by the Fairchild Camera & Instrument Corp. of New York.

Details of the sight's construction and operation were given by Erwin Hale, engineer in charge of airborne fire-control instruments for the Fairchild Corp. at the national fall meeting of the Institute of the Aeronautical Sciences at Dayton, Ohio. Hale is co-inventor, with Irving Doyle, another Fairchild engineer, of the instrument, which is designated by the Army as the "K-8" gunsight.

Describing the sight as "an electrical brain," Hale modestly said it "has provided a material advance" in the art of aircraft gunsighting.

With the K-8, the effective range of .50-cal. machine guns has been extended to more than 1,000 yards; without it the maximum range at which hits might be expected has been only 400 to 600 yards, and even then the probability of obtaining a hit has not been very high, he told the Institute.

"As much as 50% to 90% as many hits have been ob-

EDITORIAL

Three New Types of Aircraft Instruments Appear Simultaneously

IN April and May, 1942, when the mast-head of *Aviation Instruments* was being designed, we listed what were then all the important classes of aviation instruments—nine categories in all. During all our work on systematic classification, we did not even once think of an "instrument" that would take the place of the operational script. As for stall-warning instruments, most of them were in the drafting-board stage and our "Navigational" class took care of all future developments along this line as well as in ice-formation-signalling instruments. As for gun-sights and other gunfire-control instruments and gun-position servos, they THEN made up a "miscellaneous" category of relatively minor importance to our readers—even to our Armed Forces readers.

Well, the situation has changed . . . and is still changing. Three of the articles in this issue disclose details of three new instruments which are not only novel and interesting but IMPORTANT. The new principles they utilize are destined to benefit various non-aviation fields. No wonder the field of aviation instruments is so fascinating to so many people! It may not be amiss to repeat what we said in our June 1942 *Instruments* editorial: "Many branches of science and industry are beginning to be indebted to that precocious youngster Aviation Instrumentation." —MFB

tained with the K-8 as when firing at a stationary target from a stationary platform," Hale said, adding: "When it is realized that a pursuit ship must come within 200 to 400 yards of a bomber in order to score effective hits, it is apparent that the K-8 provides a really deadly defense against pursuit attack. In order to press home an attack, a pursuit plane must fly through 600 to 800 yards of .50-cal. machine gun fire that is almost completely accurate."

Fairchild K-8s are installed in aircraft gun turrets to provide automatically the correct deflection between the line of sight and the gun to insure hits on enemy aircraft. Using this system it is only necessary for a gunner to keep a ring of light in the sight lined up with the target to set up the correct deflection of the gun to compensate for all factors which affect the course of the bullet in flight and to provide the necessary lead to compensate for the enemy aircraft's relative velocity.

All the computation is done electrically, and the final voltage representing the desired vertical and horizontal angles between the line of sight and the gun-bore is fed to an electronic servo system to provide the desired offset.

The K-8's development was begun in 1938 at the Fairchild laboratories, and the sight has been in production by the Fairchild Corp. and in combat use by the Army Air Forces many months.

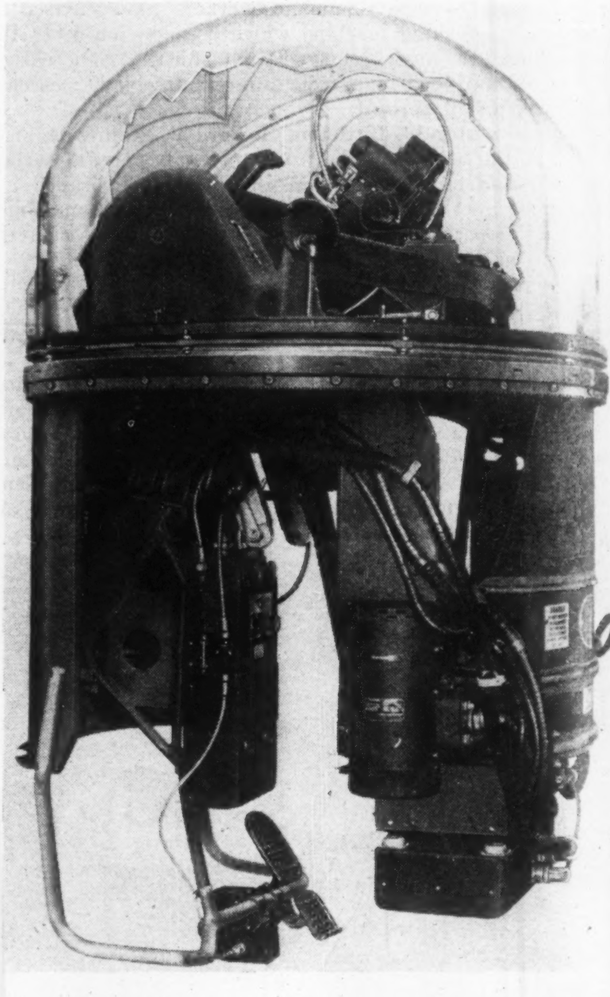
There is one other electrical airborne gunsight in use. About a year after Fairchild engineers began work on their sight, a development was started in England, and the British engineers arrived at the same conclusion in their method of computation. However, Hale said that this British sight (in manufacture in England and the United States) "does not provide as complete a solution to the problem."

In his talk before the Institute, Hale reported that "although the electrical computing system in the Fairchild sight was of course developed primarily for using against enemy aircraft, it will have many applications in post-war developments. It is particularly adaptable for complex problems involving several variables which are difficult or impossible to handle by mechanical means. In fact, the more complex the problem, and the more variables involved, the greater the necessity for use of an electrical system to obtain an accurate solution without delay and with minimum equipment and expense."

Discussing the difference between the K-8 and the earlier mechanical gunsights, Hale said that since many of the parts of the electrical computer are standard radio equipment and a large part of the assembly work consists of wiring up the various components, considerably less skilled help is required in manufacture of electric sights than in production of mechanical systems, resulting in lower first cost and cheaper maintenance.

He went on to say that if mechanical sights were built to arrive at solutions as complete as those computed by the K-8, they would be so complex and so large that in all probability they would fill the aircraft turret, leaving no room for the gunner. With the electric sight it is possible to include all the factors which should enter into the computation, but in the mechanical systems it has been necessary to eliminate some of the factors entirely and to provide only partial compensation for some of the remaining factors.

One of the obvious advantages, too, is that electrical computation is instantaneous—a matter of great importance when the gunner is dealing with target speeds of 300 to 400 m.p.h. and bullet velocities of 2,700 f.p.s. Moreover,



Showing the Fairchild electrical computing gunsight, wi its four components disposed in a revolving upper turret of bomber. The gunner sits behind the sight component (top), wit his foot on the pedal (bottom). Before action he sets three dia on the control panel (just above the foot pedal), recording th altitude and air speed of his own ship and the wing span of th target plane (after he recognizes the type). Then he looks throug the sight itself—a circle of orange light with a dot in the center Using the foot pedal to regulate the circle's size, he frames th target from wing tip to wing tip in the circle. The system the instantaneously makes all the necessary computations; all the gunner has to do is press the trigger. The fourth component of th K-8 is the power unit, nestling out of the way at the bottom of th turret (right of the foot-pedal).

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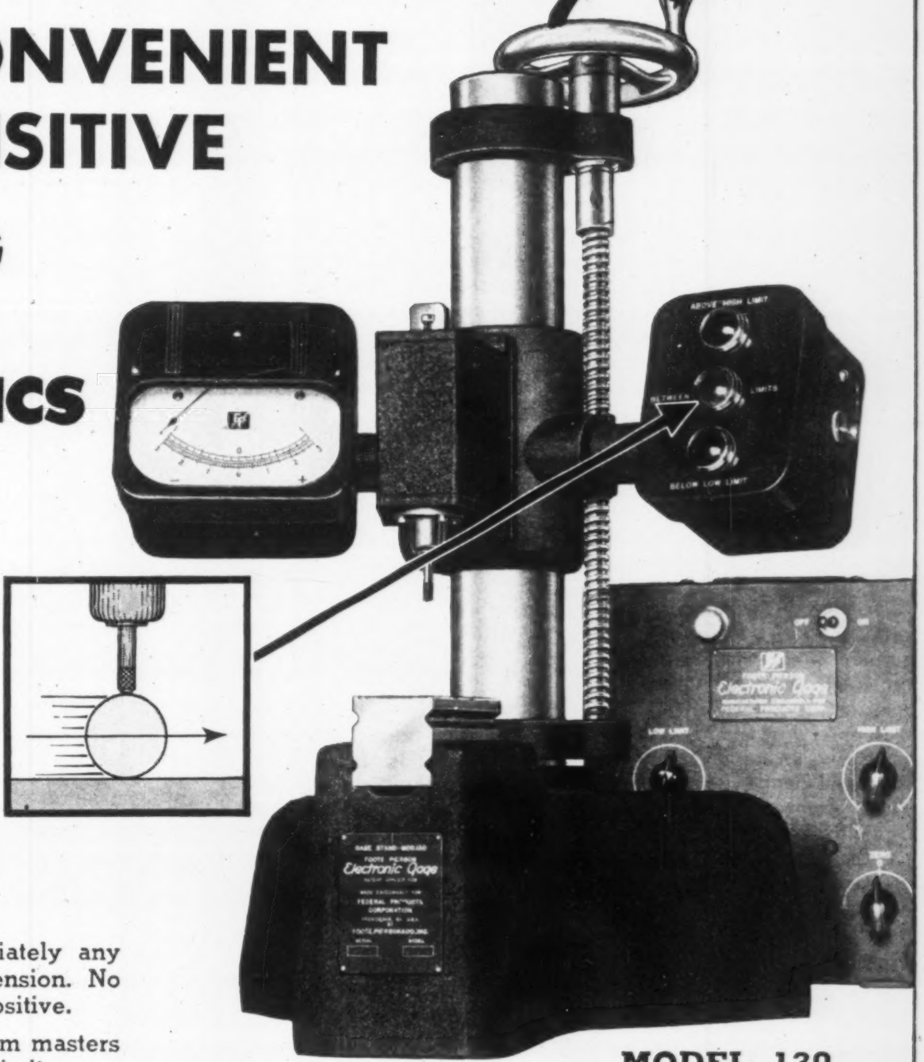

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PRECISION MEASURING INSTRUMENTS

there is no backlash and consequently no necessity of adjustments for effects of wear.

Gunsights for aircraft require two major compensations: the lead which compensates for relative velocity between the bomber and the target, and the correction for gravity and windage known as ballistic deflection.

Lead is determined from the product of angular velocity and time of flight of the projectile, and time of flight in turn depends on five factors—azimuth position of the gun, gun elevation, range of target, indicated air speed of the bomber, altitude of the bomber. Ballistic deflection depends on these same five factors, too, but there is no exact relationship between the two, so it is necessary to compute them separately.

Mechanical computers have had to neglect the effect of altitude and indicated air speed and, in further simplifying their problem, it has been necessary to use only two of the remaining factors at a time for a given computation.

As an example, Hale said, in computing the vertical deflection mechanically it was possible to include only the gun's azimuth position and elevation, the effect of range being neglected altogether. But in the Fairchild sight, with all factors computed, it is possible to produce an almost complete solution under all conditions.

The result with the Fairchild gunsight is a series of scoring records three to four times greater than any previously chalked for mechanical sights. The percentage of accuracy is also "considerably higher" than obtained with the British-designed electrical sight.

Despite the complexity of its electric and electronic circuits, the K-8 is relatively simple for an air gunner. Once a gunner is experienced in operation of the power gun turret itself, he needs only about five hours' instruction to operate the K-8 competently.

Repair and maintenance of the electrical gunsight is, naturally, an important problem: for a year and a half the Fairchild company has been operating a school in New York where Army technicians, selected for their radio and electronic background, are given six weeks' training. These men are then detailed to bases out of which bombers using the K-8 are flying. In addition, Fairchild has technical representatives, skilled in repair and maintenance of the sight, who not only operate at these bases in an advisory capacity, but conduct additional schools for Air Forces men.

Instruments Make Air-flow Smoothness Visible to Pilot

CONTINUOUSLY indicating the flow of air over an airplane wing, a new system which thus enables a pilot to know at all times whether the craft has sufficient flying speed was described by R. D. Kelly, Superintendent of Development for United Air Lines, before the national aeronautic meeting of the Society of Automotive Engineers at Los Angeles.

Kelly disclosed that United has spent seven years of research into methods of showing the actual condition of airflow around an airfoil during flight. Out of this, he said, has emerged an instrument for the pilot compartment of the plane, electrically connected with a number of airflow-sensitive pick-ups (Fig. 1) mounted on the upper surface of the airplane wing. Small vanes in these units are moved by the wind stream and, in turn, open or close electric circuits which actuate lights on the instrument board of the plane.

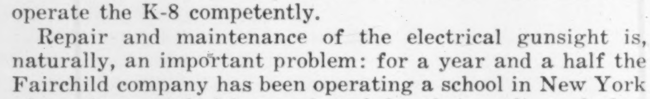

Fig. 1. Schematic section of UAL vane type airflow pickup. (A suction type was also described by Ray Kelly.)

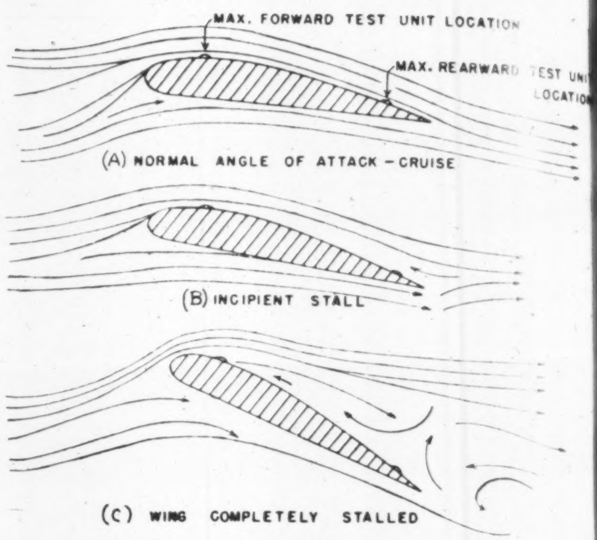
MAX. FORWARD TEST UNIT LOCATIO
MAX. REARWARD TEST UNI LOCATIO
(A) NORMAL ANGLE OF ATTACK – CRUISE
(B) INCIPIENT STALL
(C) WING COMPLETELY STALLED

Fig. 2. Basis of operation of UAL stall-warning device: airflow about an airfoil section at various angles of attack.

As the plane takes off, all the instrument-board lights ar on. As speed is attained, they begin to go out—evidence t the pilot that smooth airflow is being established over th wing. When all the lights are extinguished, the pilot know that he has established smooth airflow and that his craf has become airborne (see Fig. 2A). Any subsequent flas of lights on the instrument board immediately will war the pilot that the airflow over the wing is becoming turbulent (Fig. 2B) and that a further decrease in flying spee is to be avoided for reasons of efficiency and safety.

Kelly said that the airflow device has not yet been installed in present transport planes but indicated that it ma come into considerable use as larger airplanes go into service in the postwar period.

New Type of Aircraft Instrument Is Guide to "One Best Way"

A TINY instrument which makes pilots' jobs easier i flying even the biggest commercial and military transport planes has been developed by United Air Lines, according to Captain Ralph S. Johnson, United's veteran chie test pilot.

The device is merely a simplified check list of coördinate flight crew duties arranged in an instrument conveniently accessible to pilot and co-pilot, Johnson reported in a pape presented at the national aeronautic meeting of the Societ of Automotive Engineers in Los Angeles.

Constructed with a light inside to provide night illumination, the instrument includes two manually-operated rollers by means of which a simplified operational script, printe on a narrow roll, is moved across a window opening. It i installed above the center of the instrument panel for eas visibility.

Pilots always carry an operational manual containin tested procedures to follow for reliable, safe operation of the plane. Johnson said that the "Coordinator" contains the same procedures, rearranged so that sequences are in simple, continuous paths of movement. Instructions are listed in easily-read phrases.

The veteran test pilot said the "Coordinator" had reduced engine run-up time from nine to two and one-half minutes at United's central maintenance base and bomber modification center at Cheyenne. "Such saving is of considerable value to airline operations as it reduces congestion and delay on the airport and speeds flight schedules," he pointed out. This particular example was only one of a number cited by Johnson. Here are two others:

Example No. 3: Tests were made simulating the failure of one engine. During these tests it was found that the flight officers, using his own method, required from four to eight minutes to com

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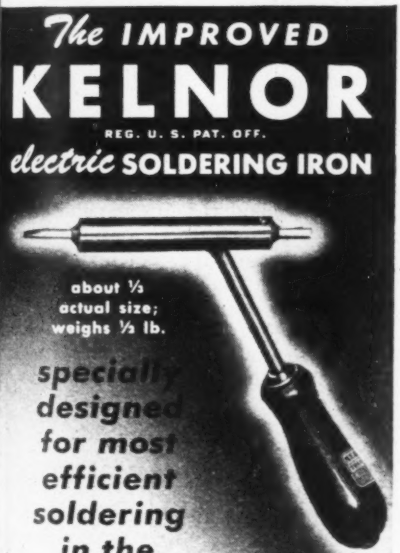

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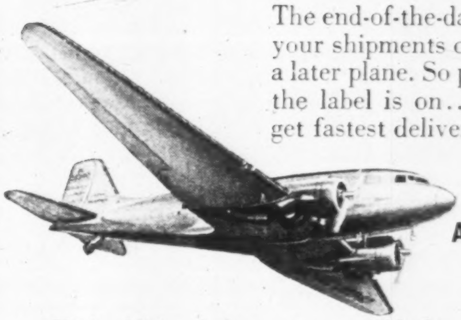

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plete all of the items considered necessary for one-engine-o flight. . . . When the same pilots employed the Coordinator pa for the accomplishment of one-engine-out operation the ti required to complete the operation was 45 seconds.

Example No. 5: During the past two and one-half years, fou flight test crews at United Air Lines Cheyenne Base have fligh tested more than 5000 heavy bombers and air-line transport ai planes without an incident. These crews were composed of firs officers from the air line, none a captain and none with fou engine experience. A complete change of flight personnel was suffered on the average of every eleven months. This combination

Captain Johnson and his "Coordinator"

frequent changes of relatively inexperienced flight personnel presented an excellent opportunity for the testing of the flight dec Coordinator and its script. . . . Observers . . . have stated that al of the crews appeared to operate the airplanes in an identica manner. The Coordinator and its script contributed principally t this accomplishment.

Concluded Johnson: "The Coordinator instrument and th operational script must be considered inseparable befor success is to be attained . . . An operator may have an adequate operational script, but because it is not instantly visible to the pilots throughout the flight the script will fal into disuse. . . . Flight officers should not have to searc about the airplane for the script. The flight officer shoul not be expected to attempt to read the script off of a car while holding it and a flashlight in one hand and attemptin to move the controls with the other. . . ."

Crampton-Lenox-Martin "Rivetscope" Sets New Length-diameter Record

SO long and thin that several instrument laboratories declared that it could not be made, a "rivetscope" form o borescope is today carrying the examining eyes of inspectors at The Glenn L. Martin Company, Baltimore, Md., into what a few weeks ago were considered inaccessible structures.

The instrument is 110″ long and ⅝″ O.D. *Instruments* does not run a picture of it because the photo would be a line 3⅜″ long (column width) and 0.019″ thick. It was developed by Dr. George S. Crampton of the Lenox Instrument Co. in collaboration with engineers of the Martin Inspection Department to check blind rivets in a new type wing construction that could not be reached throughout its entire length by the borescope which it would admit. Previously, it had been necessary with this type of construction to x-ray the entire wing and piece the shadowgrams together in order to determine whether all the rivets were properly et—an expensive, time-consuming procedure which is far nore difficult to interpret.

The new Martin rivetscope consists of a one-piece seamless steel outer tube and a seamless steel liner which spaces pproximately 20 achromat and simple lenses. A standard yepiece provided at one end together with a connection or a 6-v transformer, while the other end carries a light nd mirror similar to those in a conventional borescope. By reason of the extreme length of the tube, the lenses are round to provide a 2× magnification at the eyepiece. All wiring in the new Martin instrument is carried internally between the outer tube and inner liner with the outer tube itself serving as return. The outside tube is scaled in feet and inches to aid in locating defective rivets. A removable metal foot which rides over rivets is provided at the scope end of the tube to facilitate sliding it into long narrow sections. Further aid in handling the new instrument has been provided in the form of wooden stands containing a plastic roller which may be adjusted to the height of the entrance to the structure being inspected.

The new Martin rivetscope is amazingly rigid, with little "whip," yet weighs only ten pounds and can be easily handled by women employees. In addition to its intended purpose it is solving inspection problems ranging from inspection of an occasional defective rivet in PBM bomb bay fairings without removing the skin, to examination of long lengths of defective tubing.

ELECTRIC GAGING METHODS

Continued from page 744

ively employed in electric gaging;[206] these instruments are devices for comparing currents, and their applications are confined to systems in which relatively large currents flow. Many resistance-type gaging circuits carry only a few milliamperes of current, and in them it is more efficient to operate on a potential basis rather than a current basis. Other circuits used for balancing or comparing currents, employing alternating currents with rectifiers and d-c. indicating instruments, previously described in connection with variable-inductance type gaging elements, can equally well be employed with resistance-type gages.[102] See especially Fig. 50C.

A particular application of the variable-resistance element, and of electric circuits specially suited to it, is found in the telautograph—the familiar instrument found in railway stations, hotels, and the like, for "writing at a distance." One form of this circuit has been put to good use in the testing of variable-resistance elements in a semi-automatic manner;[207] it is interesting especially because it incorporates two elements in such a manner as to give a two-component record on a cathode-ray tube screen. Its basic diagram is shown in Fig. 97, and in this diagram is a sketch showing the sort of pattern which is produced on the screen of the cathode-ray-tube. The coördinate axes are of course permanently drawn on the screen. When the two units, operated in unison, produce a straight line on the screen, it is an indication that they are similar. In the telautograph, of course, the indicating device is a stylus, operated by two magnetic motors at right angles to each other.

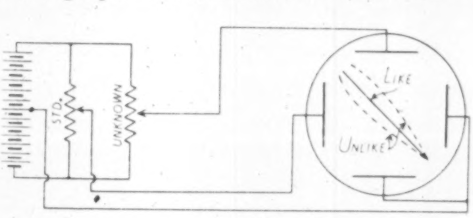

FIG. 97

To be continued

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(206) P. A. Borden and M. F. Behar. Bridges and their Applications. *Instruments,* Vol. 7, 1934, pages 229-244.

(207) Leon Podolsky. Electronics in Resistor Manufacturing. *Electronics,* Vol. 6, No. 7, July 1933, pages 180-181.

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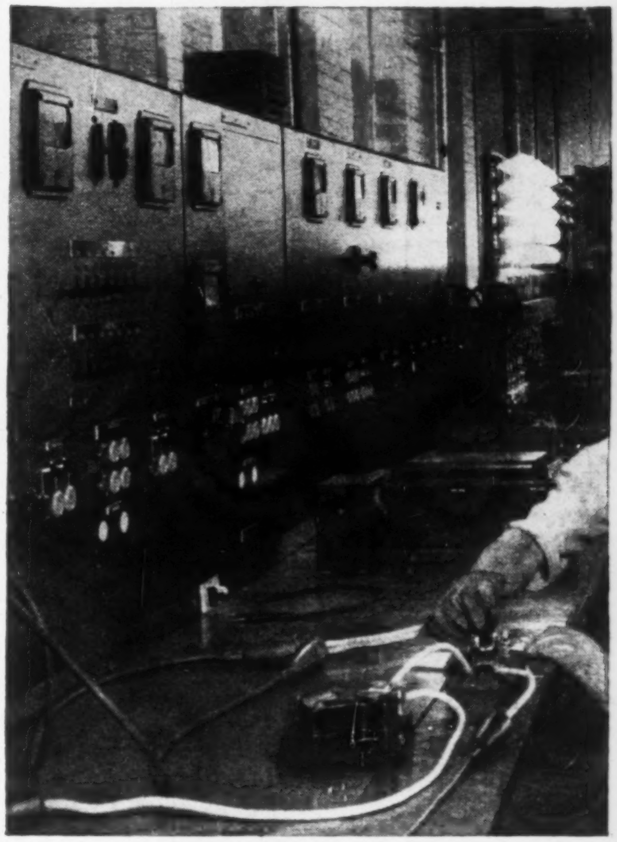

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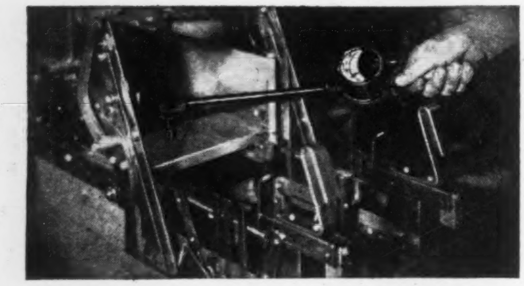

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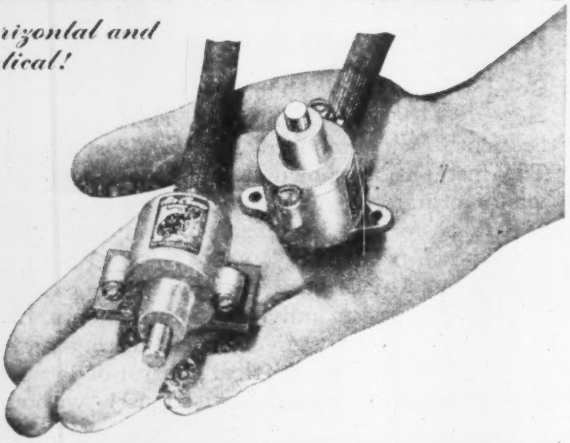

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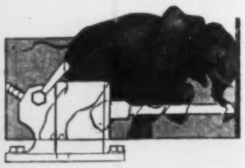

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ELECTRON TUBE APPLICATIONS

Continued from page 747

When the flame fails, the current through it ceases and since there is no longer a positive potential opposing the negative biasing potential, the grid instantly becomes negatively charged. This cuts off the plate current, de-energizing the relay and cutting off the gas supply to the burner. A 1-megohm resistance in series with the flame is introduced to limit the current to a safe value in case the flame electrode should become grounded accidentally.

This equipment is simple to install. The flame electrode is a stout metal rod of an alloy suitable for combustion chamber conditions. Supplied in a standard length of 18 though it may be had longer if desired, it may be bent to suit various burner and combustion chamber arrangements. The rod is supported by means of a heat-resistant porcelain insulator to the outer end of which is attached a metal protective cover tapped for conduit fitting. The insulation has to be of a high order.

The Wheelco Instrument Co. "Flame-otrol" is different from the system just described in that it uses only a single tube in a self-rectifying circuit. The tube used is the 5 type which is a twin-triode, that is, it consists of two triode sections with a common cathode and heater circuit.

Closely allied to systems of measurement employing sensitive contacts in combination with amplifier are systems in which the weak initiating impulse is obtained capacitively or inductively. There are a great variety of these, but a typical application (which was shown in Fig. 198), will serve to show the principle. This is a viscosity tester, previously described.

Sound Level Meters and Analyzers

While sound level recorders or noise-measuring instruments are properly classified under amplification applications, they may be referred to here because all of them employ microphones of one kind or another to pick up the sound to be measured. In all such instruments the sound is picked up by the microphone and the resulting current amplified suffciently to be read on an indicating instrument. In most instances, only the intensity of the sound needs to be measured, but in other cases it is necessary to analyze the frequency characteristics of the sound. This involves the use of selective filters by means of which the noise is measured only within a narrow range of frequencies. These filters, consisting of inductances and capacitances, are connected between the microphone and the amplifier and, by cutting in these filters one by one, the noise is divided up into narrow discrete bands. In this way the relative loudness of each component can be measured.

The sound analyzers in common use today can be classified according to their selectivity characteristics. The degenerative type is an example of those having a constant-percentage characteristic, wherein the band width being analyzed widens proportionally as the frequency is increased. In another type, known as the heterodyne analyzer, the band width being analyzed remains the same for all frequencies. This type gives almost razor-sharp selectivity at the higher audio frequencies.

An analyzer of this type embodying a recording mechanism, developed to meet the industrial demand for an effective recording instrument, is the Western Electric Co.'s "RA-281 Recording Sound Frequency Analyzer." It consists of a pick-up device which is either a dynamic microphone or a moving-coil type vibration pick-up, a heterodyne

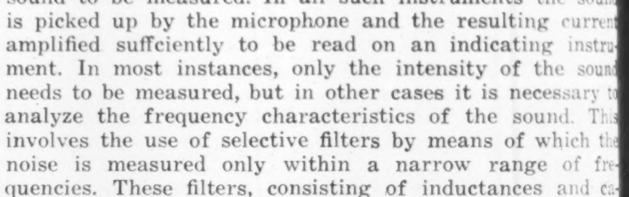

Fig. 209. Block diagram of the Western Electric Recording Audio Analyzer with frequencies present in each section during analysis of a 1000-cycle sound.

nalyzer with associated audio-frequency amplifier, and a pecial level recorder which automatically plots the response t each frequency over the range being studied. The comlete record is produced on wax-coated paper in two minutes r less. Fig. 209 shows a block diagram of the RA-281 nalyzer. For simplicity, assume that the microphone is icking up only a 1000-cycle (1-kc.) sound. After amplificaion this 1-kc. audio-frequency signal is combined with the 9-kc. signal from a local r-f. oscillator to produce the sum nd difference frequencies of 48 and 50 kc. along with the 9 kc. signal. The crystal filter passes a band a few cycles ide centered on 50 kc., hence only the 50-kc. component (the upper side band) gets through. This is amplified and ombined with the 49-kc. local oscillator signal in the emodulator to produce the original 1000-cycle signal again.

It will be obvious that eventually the same action holds if he microphone is picking up a complete audio spectrum, he noise produced by a high-speed machine for example. All of the audio components beat with the 49-kc. oscillator ignal to produce sum and difference frequencies, but only he 50-kc. component caused by the 1000-cycle input freuency will get through the crystal filter.

Assume now that the local r-f. oscillator is slowly varied rom about 40 kc. to 50 kc. while the microphone is still icking up all the audio frequencies which make up the oise. At 40 kc., the 10,000-cycle component will give a 0-kc. beat which will get through the filter, while at 9.99 kc. the 10-cycle component will produce the required 0-kc. beat. Thus, as the sweep is made from 40 to 50 kc., ach audio component in turn will produce its own freuency in the output of the analyzer.

The quartz crystal filter normally supplied with the nstrument is centered on 50 kc. and passes a band of freuencies only 5 cycles wide, 2½ cycles on each side of 50 c. Filters with band widths of 2 or 10 cycles can be suplied and others of 20, 50 and 200 cycles are also available. Up to three such filters can be built into the analyzer. The utput of the crystal filter is amplified in the r-f. amplifier stage and then combined with r-f. oscillator signal in he demodulator stage by electronic mixing. This results n a difference frequency corresponding to the frequency eing analyzed at the moment.

The output of the demodulator stage is further amplified y additional a-f. amplifiers and fed either to an indicator r to the level recorder.

In use, the frequency of the local r-f. oscillator is varied smoothly by a small synchronous motor which is lowered ver the tuning knob of the variable condenser which tunes he oscillator circuit. About two minutes are required to cover either one of two audio-frequency ranges which may be selected by a key on the panel of the instrument. One f these provides a range of 10 to 1000 cycles and the other from 100 to 9500 cycles. For special requirements the nalyzer can be modified to operate up to 25,000 cycles.

The recording unit which is contained in a separate case s especially ingenious. The schematic circuit of this part f the analyzer is shown in Fig. 210. This recorder uses a

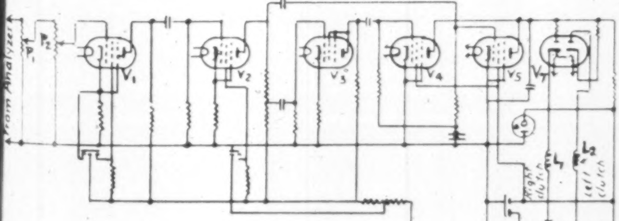

Fig. 210. Schematic circuit diagram of the Western Electric noise level recorder.

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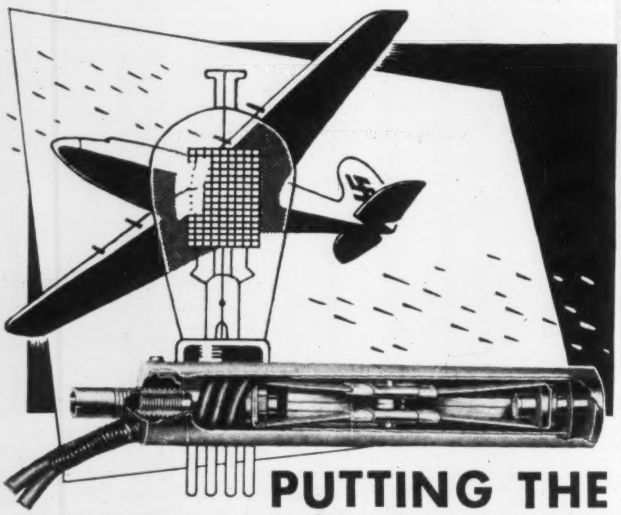

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special bridge circuit developed by Swartzell and Bede for the clutch mechanism driving the marking scriber. The a-f. signal from the a-f. output stage of the analyzer show on the block diagram, Fig. 209, is applied to a 5-stage a- amplifier in the recorder through voltage-dividing resisto P_1 and P_2. The resulting audio signal is applied to a bridg circuit arrangement employing a full-wave rectifier, V in two legs and clutch coils L_1 and L_2 in the other leg

The recording mechanism is outlined in Fig. 211. consists of a constantly-moving recording drum and stylus or scriber carried on an endless wire belt drive through magnetic clutches only when motion is required The movable contact arm of voltage-dividing resistor P is mechanically linked with the scriber arm.

Initially P_1 (Fig. 210) is adjusted so that equal curren flow through both clutch coils for a particular desire scriber position and a corresponding setting of P_2. Now if the a-f. input level increases above this initial valu more current will flow, say, through the left clutch coi causing this clutch to attract a rotating Permalloy dis which clamps on the endless wire belt which moves th scriber. The action of the clutch then moves the scribe in the direction of higher signal level and records the trac on the continuously moving drum. The movement stops however, when P_2 has been moved sufficiently to balanc the clutch currents again. Then both Permalloy disks jus clear the wire. The opposite action takes place if the a- signal level drops.

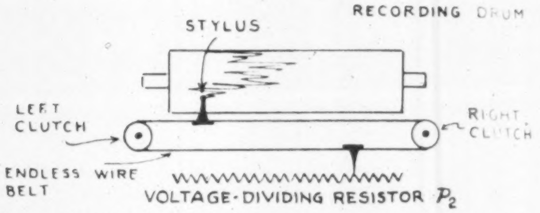

Fig. 211. Outline sketch of the recording mechanism of the Western Electric audio analyzer.

The action described is very fast and the instrument i able to respond to changes in sound intensity as great a 58 db per second. The paper ordinarily used for recordin is colored paper, 4½" wide with a wax coating.

This instrument has been described in considerable de tail because it is one of the most highly developed soun analyzers made and is indicative of what can be accomplished by electronic methods.

Electronic Circuits For Resistance-wire Strain Gages

An interesting application making use of the extrem sensitivity of the vacuum-tube amplifier is the resistance wire type of electronic strain gage, developed to determin the stresses in structures and machines while under load o in operation. Many of these are in commercial use today in various industries, the development came about largel because of the demand for such gages in the airplane industry for use in stress analysis.

The principle of operation of these devices is relativel simple and it makes use of the fact that when an electrica conductor is subjected to mechanical stress, its electrica resistance changes. Hence, if a wire is firmly cemented to a structural member, as the surface of the member undergoe small linear changes of dimensions as a result of stress the wire also undergoes changes of dimensions and thi results in a variation in the electrical resistance of th wire. In the surface strain gage, the dimensional change cause a proportional change in the electrical resistance o the wire and by means of suitable electron-tube circuit this change in resistance can be measured in terms of th strain, from which the stress can be computed.

The problem involved in measuring this change in resistance is not as simple as it might seem. The principal difficulty here lies in the fact that variations in resistance due to temperature changes or from other causes may be several times as great as the variation in resistance cause y the surface strain. Differences in the method of installing hese gages may cause an initial variation in resistance far reater than that due to the strain. For example, the initial esistance of a strain gage might be 120 ohms with an itial variation of ± 0.75 ohm, whereas the variation in esistance due to strains would be ± 0.25 ohm. For a horough and practical discussion of this type of strain age, refer to the articles by H. C. Roberts in *Instruments.** A description of a strain gage of this type was presented y D. M. Nielsen of the Foxboro Co. in *Electronics.*† A lock diagram of this instrument is shown in Fig. 212. This s a self balancing resistance bridge for the continuous ecording of strain on a single gage. The bridge circuit, it ill be noted, is supplied with current from a 1000-cps. lectron-tube oscillator. A variable capacitor is used instead f a slide-wire as the balancing arm of the bridge. This apacitor is coupled both to the recording pen and a solenoid motor as shown. The amplified unbalance voltage is applied o both grids of a dual-triode balance control tube, which hrough an ingenious circuit produces two pulsating direct urrents in the output circuits. The difference between hese voltages is approximately proportional to the unbalance voltage in the bridge circuit. This difference has a olarity depending upon the direction of the bridge unbalance. These voltages are amplified by a push-pull power tage and applied to the two coils in the solenoid balancing rive motor. The power amplifier is biased so that when he bridge is balanced and no voltage is impressed on the alance control tube grids, the plate current flowing in both olenoid motor coils is equal and about 40% of maximum. n this way continuous balancing action is provided.

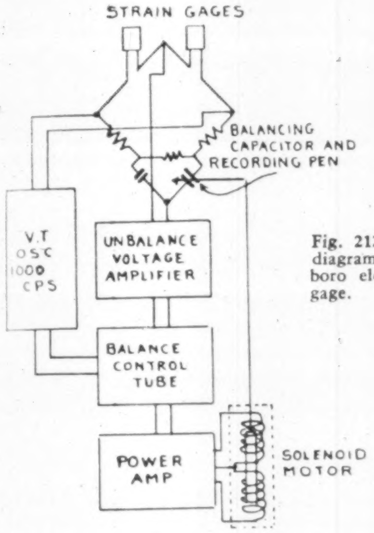

Fig. 212. Functional diagram of the Foxboro electronic strain gage.

Electronic Relay Using Thyratrons

Earlier in this article, under the discussion of electronube micrometers, reference was made to an electronic relay sing thyratrons. This particular relay was developed by oseph Razek, consulting physicist of the Burgess Laboraories at Elgin, Ill. and was fully described in *Instruments.*** The wiring diagram of this relay is shown in Fig. 13. In addition to taking advantage of the usual properties f the grid-controlled rectifier tube, a unique feature of his circuit lies in the fact that the operating output curent does not pass directly through the grid-controlled recifier tube. Instead, a special transformer is used. In this ransformer the impedance of the coil which is to carry he output current is altered greatly by the degree of sațuration of the iron core. This degree of saturation can be ontrolled neatly by means of a much smaller current flow-

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*Sept. 1944, pages 534-535, 544, 546, 548, 550, 552, 554; Oct. 944, pages 603-605, 626, 628.

†Dec. 1943, page 106.

**March 1944, pages 132-133, 162.

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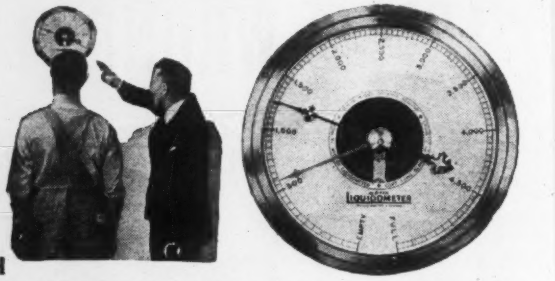

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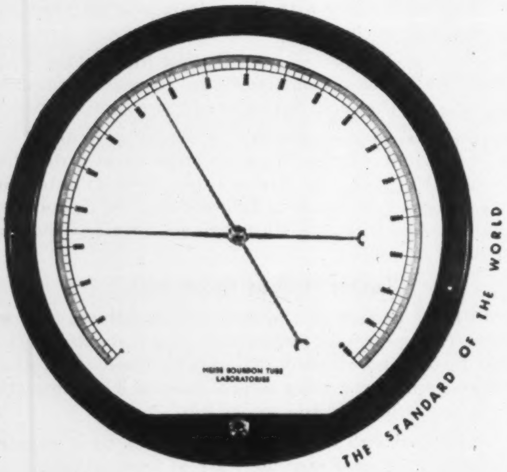

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ing through a large number of turns wound around the same core. As a fluctuating direct current flows through the coil of a large number of turns, the magnetic core is saturated, thereby reducing the impedance of the other winding and allowing the output current to flow through this winding.

The advantages resulting from the use of the special transformer (T_2 in the diagram) are that a smaller grid-controlled rectifier tube can be used to control a relatively large amount of power (since the output current never needs to pass through the rectifier tube directly), and that the output circuit gives a better a-c. wave. This would not be the case if the output current passed through the rectifier tube. In the latter case, the best that could be obtained would be a pulsating direct current and while such a current can be made to operate most a-c. devices, the wave-form does cause difficulty at times.

In the wiring diagram, transformer T_1 supplies the filaments of the grid-controlled rectifier tubes V_1 and V_2. The tubes are so connected that when one tube fires, the other tube is extinguished. This results in a sharp off-and-on action, desirable in certain applications. When the actuator contacts are closed (by any device such as a micrometer, thermostat, etc.) ground potential is impressed on the grid of tube V_1 which causes the plate current to flow through the input winding of transformer T_2. The core of this transformer T_2 becomes saturated, reducing the impedance of the output winding which is in series with the input voltage and the output circuit L_1. Therefore, if a load has been connected across the output circuit L_1, it will be in series with a low impedance and hence current will flow through this winding. At the same time, since tube V_2 is not firing, the core of transformer T_3 will not be saturated and its output winding in series with the output circuit L_2 will have a high impedance. This will result in no current or, at the most, a negligibly small current flowing through the output circuit L_2.

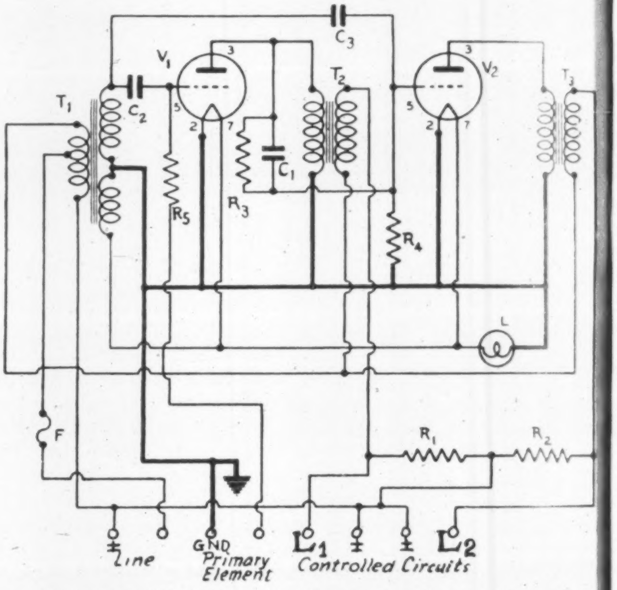

Fig. 213. Wiring diagram of an electronic relay using thyratrons.

If now the actuator contacts are opened, the action will immediately reverse since Tube V_1 will now have a negative potential applied to its grid causing the tube V_1 to become extinguished. The plate current of this tube will no longer flow through the winding of transformer T_2 and the impedance of the winding in series with the output circuit L_1 will be greatly increased, reducing the current in the output circuit to a low value. Immediately, the grid of tube V_2 will become positive to a sufficiently extent to allow a plate current to flow through the plate winding of transformer T_3 which will then reduce the impedance of the winding of transformer T_3 in series with the output circuit L_1, allowing the current to flow through this output circuit. Owing to the capacitors C_2 and C_3, the action is such that when one tube becomes energized, the other tube becomes de-energized immediately.

Summarizing: closing the actuator contacts results in energizing output circuits L_1; opening the contacts results in energizing output circuit L_2 and de-energizing output circuit L_1.

This circuit is adaptable to a variety of purposes; it can be used in connection with a micrometer or with a thermostat. In one case, described by Mr. Razek, an incandescent lamp was connected in the output circuit L_2 and placed in a small box near a bimetallic strip operating the contactor. The strip was so arranged that if the temperature went down, the contact opened causing the lamp to glow. The response of the bimetallic strip was so rapid that the lamp would go on and off many times a second. This shows the extremely small contact travel required to cause a definite off-and-on operation of the unit connected in the output circuit. The extreme sensitivity of this relay and the fact that the contacts can operate through a high resistance make it adaptable to many industrial measurement and control devices.

XXX. APPLICATIONS OF THE PHOTOELECTRIC EFFECT IN MEASUREMENT

The photoelectric effect, discussed in considerable detail in previous articles lends itself to the field of instrumentation in two ways: first, as a direct method of measuring both the intensity and quality of electromagnetic radiation (light, x-rays, etc.) and secondly, as a means of linking mechanical or optical systems with electric circuits by means of a beam of light. Although the first application is the most fundamental, it is in the latter field that the photoelectric effect finds its greatest use and also it is this type of application that appeals most to our imagination. Nothing that we can think of has less substance than a beam of light; there is nothing so tenuous; and to think of a light beam as a tangible connecting link between the moving parts of heavy machinery hinges on the fantastic. It belongs to the same category of ideas as those of fairies dancing on moonbeams.

One of the simplest, yet one of the most astonishing, features at the opening of the Chicago "Century of Progress" in 1933 was the closing of the master switch which controlled the lighting by the light from the star Arcturus, 40 light years away. The thing itself was very simple, it merely involved the placing of a photocell in front of the eyepiece of a telescope at the Yerkes observatory so that when the star crossed the field of vision, the resulting amplified output of the photocell, through the agency of relays, closed the master lighting control switch at Chicago, but to the layman nothing seemed more incomprehensible than this.

As indicated in earlier articles, the phototube and the photocell respond not only to the intensity of the radiation falling upon them, but also to the kind of radiation, that is to the frequency of radiation. Like the eye, they are color-sensitive and so can be made to respond to, or distinguish between, different colors, not only in the visible range but in the ultraviolet range as well. Thus phototubes and photocells have an important application in instruments designed for color analysis, and today there are available a number of highly accurate colorimeters.

Among the earliest and also perhaps the simplest applications of phototubes and photocells was the photometry of lamps. Until the advent of phototubes and photocells, the photometers available all depended upon a comparison of the measured light source with that of a standard light source by means of the eye. While many of these were quite accurate, the measurement always involved the personal element of the observer and this was not an advantage.

The development of practical photocells at once eliminated the human equation in the measurement of light intensity or of color. If the output of a photocell is meas-

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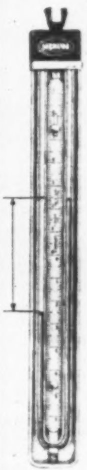

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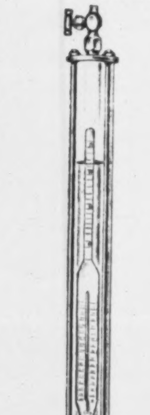

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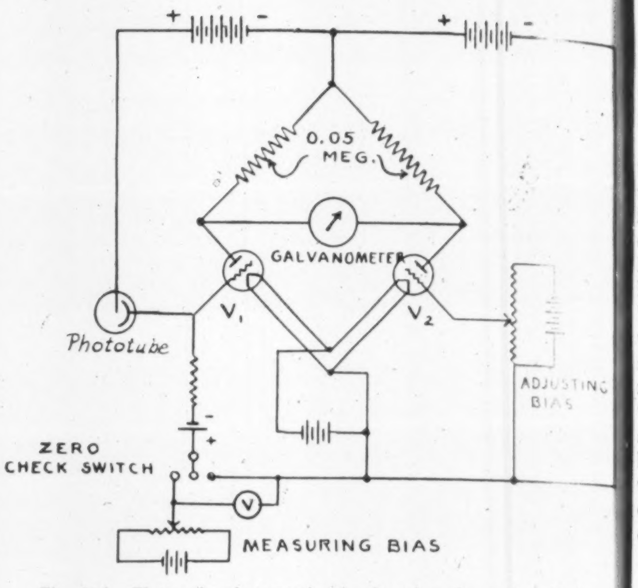

Fig. 214. Electronic photometric circuit using the null method. With the photocell dark, the bias of the first triode V_1 is made zero. Next, the bias of V_2 is adjusted until the bridge is balanced. When the photocell is illuminated the bridge is unbalanced and the amount of unbalance is a measure of the illumination.

ured by a microammeter, the latter will indicate values proportional to the intensity of illumination falling on the photocell and can be calibrated directly in terms of light units. This is the principle of the light meters used in ordinary illumination studies and, of course, also in the photoelectric exposure meters which have become so popular among photographers in recent years. Photocells are ordinarily used in photoelectric exposure meters because they require no outside source of voltage and because they have sufficient output to actuate a microammeter.

In the photometry of lamps, vacuum-type phototubes are employed in connection with amplifiers. The simplest circuit consists merely of a phototube connected to a triode amplifier with a milliammeter in the plate circuit. With the tube dark, the resistances in the circuit are adjusted so that the ammeter reads zero. Then the phototube is exposed to the illumination of a standard lamp at a fixed distance and the plate current noted. Next the light from the unknown lamp is made to illuminate the phototube and the distance between this lamp and the phototube is adjusted until the same plate current is obtained. The relative illumination from the two sources may then be calculated from the ratio of the distances.

The disadvantage of a simple photometer such as the one just described is that the response from a given lamp is a function of the phototube and amplifier-tube characteristics as well as of the voltages involved.

To overcome this disadvantage the Electrical Testing Laboratories have developed several types of circuits, one of which, using the null method, is shown in Fig. 214. With the phototube dark, the bias of the first triode, V_1, is made zero. Next the bias of V_2 is adjusted until the bridge is balanced. Then when the phototube is illuminated the bridge is unbalanced and the amount of unbalance is a measure of the illumination.

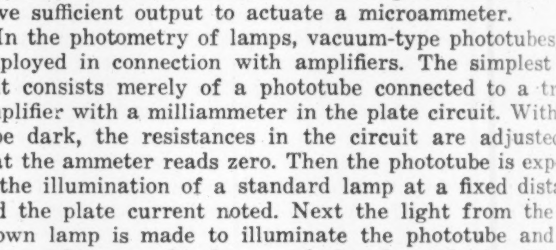

Fig. 215. Circuit used to measure the concentration of a solution by change in color.

Little need be said here regarding the use of the photoelectric effect in television and in picture transmission systems. Such systems would not be possible without phototubes and photocells and they represent a class of applications on which entire books have been written.

A useful application of the color sensitivity of the phototubes and photocells is in the chemical analysis of solutions and to some extent of vapors, by the color or the turbidity of the liquid. A simple example of an instrument of this kind is shown in diagram in Fig. 215. This particular instrument was developed to estimate the color of yellow sols obtained in the analysis of dilute silver solutions. The phototube used was a potassium phototube and it was used with various filters. In use, the bridge circuit is first adjusted to some convenient reading on the scale of the microammeter with an unimpeded light beam. This caused the microammeter to indicate a new reading. The microammeter was then brought back to the original position by means of a uniformly graded wedge. The reading on the scale of the wedge was then a measure of the strength of the solution. Since the movement of the wedge was accurately controlled by means of a rack and pinion, the concentration of the solution could be read to within extremely close limits—the 1000th part of the maximum concentration of a given solution.

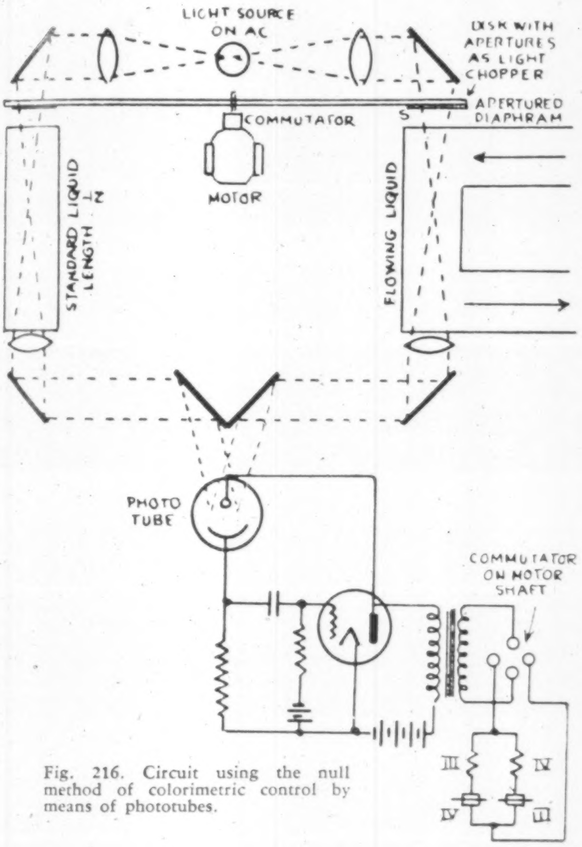

Fig. 216. Circuit using the null method of colorimetric control by means of phototubes.

Another type of colorimeter—the "Lumetron," manufactured by the Photovolt Corp.— is designed so that ordinary test tubes filled with the liquid to be tested can be placed directly in the instrument. It consists merely of a lamp, suitable holders for test tubes or color filters, a photocell, an indicating galvanometer and a power supply unit, all built into a case designed for portable use. Once plugged into the power supply, this instrument is immediately ready for readings. It is standardized by setting the needle on full-scale deflection for the blank which, in most instances, is distilled water. Then, when the blank is replaced by the sample to be tested, the reading of the latter is indicated directly by the indicator needle. This instrument is suited for colorimetric and turbidimetric tests in chemical analysis as well as for color-matching of

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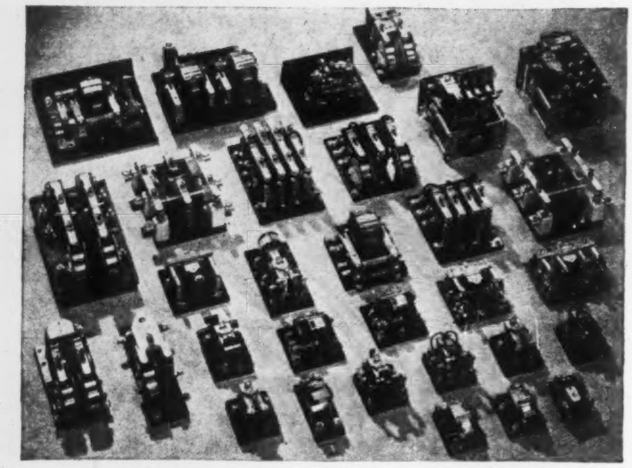

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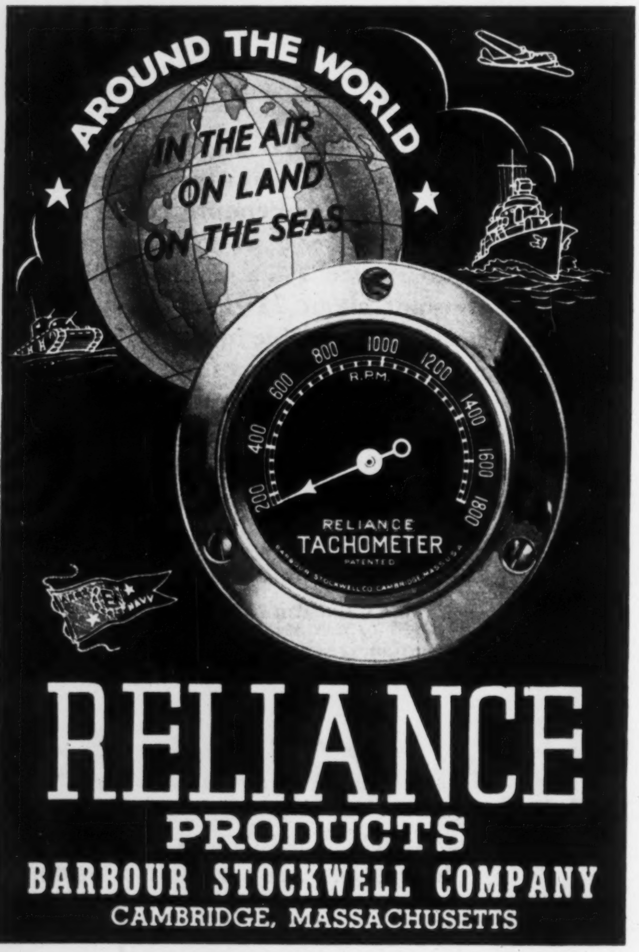

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liquids. When used for the latter purpose, use is made of glass filters which come with the instrument.

A more elaborate concentration analyzer is shown in Fig. 216. This is more than an analyzer, it is a part of a concentration regulator developed at Westinghouse and described by J. C. Alfriend before the 1933 Winter Convention of the A. I. E. E. The system was developed to regulate the hydrogen ion concentration of a flotation liquor by controlling the speed of a conveyor which feeds lime to the process and maintaining the speed constant between corrective impulses received from the phototubes. This system uses the null method and operates on the following principle.

The light beams from a single light source are directed by a system of mirrors and lenses through two different paths onto a single phototube in such a manner that one beam passes through a standard color sample and the other through the unknown liquid. The latter flows continuously. An apertured diagram is rotated in the path of the two beams so as to vary the cross-section of the beams permitted to pass through the two liquids. The sum of the apertured areas A and B is always equal to unity, the aperture A varying from zero to 100% while the aperture B varies from 100% to zero.

Thus if the light-transmitting qualities of the two liquids are identical the illumination of the phototube will be unchanged as the diaphragm is rotated and therefore the output of the amplifier tube or its plate current will be constant direct current. With constant direct current impressed on the primary of transformer T_1 there will be no output from the secondary and relays III and IV will not be energized. The relays are part of the motor control circuit.

If the light-transmitting quality of one of the liquids deviates a small amount from that of the other, the illumination of the phototube will vary as the diaphragm is rotated and the plate current of the amplifier tube will, therefore, become a pulsating direct current. With pulsating d.c. impressed on the primary of transformer T_1, the secondary will deliver only the alternating component which in phase, position and in magnitude will be proportional to the deviation in the light transmitting qualities of the unknown liquid from that of the standard liquid. Since this alternating component is rectified by a mechanically-driven commutator on the shaft of the motor which drives the feed, the direct current obtained will be proportional to this same deviation in light-transmitting quality. With relay III set to pick up at a minimum value of positive current, the relay IV set to pick up at a minimum value of negative current, a speed-adjusting rheostat and timing cycle is set in operation and this in turn corrects for the unbalanced condition.

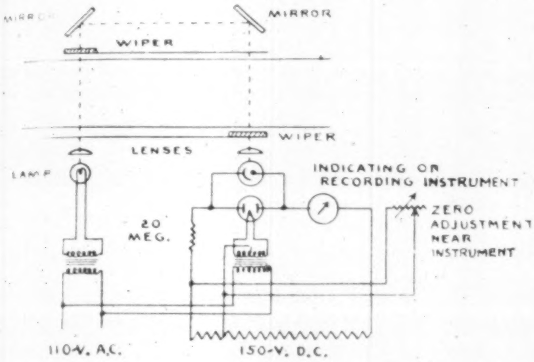
Since this circuit is a zero or "null method" and this feature is obtained by filtering out the direct-current component of the plate current of the amplifier tube, the regulator is insensitive to steady variations in applied voltage as affecting the circuit or the light source, and it is not affected by steady variations in temperature or changes in the sensitivity of the tube itself within the working range.

This circuit just described is presented to show a relatively complex and involved application of the photoelectric effect. It is typical of a number of involved arrangements which have been devised for various purposes and such arrangements are capable of almost infinite variation.

Smoke Indicators

The principle of the smoke indicator was explained in a preceding article. Such instruments operate upon virtually the same principle as the colorimeters just described except that the beam of light focused on the phototube or photocell is intercepted by smoke. Usually the equipment is mounted on opposite sides of a stack or flue, the source of light on one side and the photocell on the other. With no smoke interposed between the light and the photocell, a fixed amount of light reaches the photocell and the milliammeter in the plate circuit of an associated amplifier circuit indicates a value which may be calibrated in terms of clear stack. When smoke is carried through the light eam, the amount of light reaching the photocell is reuced and as a consequence the milliammeter in the plate rcuit of the amplifier indicates a different value, corresonding to the smoke density. The calibration may be in erms of the Ringlemann chart which has long been used to enote smoke density or it may be purely arbitrary. Such moke density measuring instruments may be either indicatg or recording.

A diagram of a General Electric smoke indicator is hown in Fig. 217. It consists of an incandescent lamp, constituting the light source, a phototube with amplifier and ndicating or recording instrument, a system of adjustable mirrors, and a motor-driven wiper to keep the lens sysem clean. The mirrors are mounted on one side of the moke flue and the phototube and amplifier on the other. The recording equipment can be located some distance way. With a clear flue, that is with no smoke interceptng the light beam system, a maximum amount of light eaches the phototube and this keeps the grid of the triode ositive, resulting in a high plate current. When smoke ntercepts the light beam, however, the amount of illumiation reaching the phototube diminishes and this causes he grid of the amplifier to become more negative. This esults in a decreased plate current.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LAMP
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20 MEG.
ZERO ADJUSTMENT NEAR INSTRUMENT
110-V. A.C.
150-V. D.C.

Fig. 217. Diagram of the General Electric smoke indicator.

Phototube Circuits

As already indicated photoelectric tubes are always used n conjunction with amplifiers of one kind or another. The utput of the phototube is so small that a sensitive galanometer is the only instrument that can be operated diectly from the phototube. Phototubes are nearly always esistance-coupled to the amplifier that follows them. It is ossible to design transformers for use with phototubes ut it is difficult to obtain high enough reactance with the ower audio frequencies, hence, resistance or resistance-apacitance coupling is usually used.

Phototube circuits are classified as to whether an inrease in illumination results in an increase in plate curent of the amplifier tube which follows it, or whether such an increase in illumination results in a decrease in plate urrent. Ir the former case, that is, where the plate curent increases with increase in illumination, the circuit is alled a "forward" circuit. In the latter case, where an inrease in illumination results in a decrease in plant curent, the circuit is known as a "reverse" circuit. Fig 218A hows a forward circuit while Fig. 218B shows a reverse ype of circuit. Both of these are direct-current circuits. In Fig. 218C and D are shown two circuits for alternating-urrent service. Fig. 218C is a "forward" a-c circuit while Fig. 218D is a "reverse" a-c circuit. It will be note that in oth of the latter circuits grid capacitors are introduced across the coupling resistor. The purpose of these capacitors s to eliminate the difference in phase between the grid and anode voltages resulting from the capacitance of the phototube and the amplifier elements. The sensitivity of these a-c circuits is less than half of the d-c circuits when operated at the same voltages.

Phototubes are also used in conjunction with thyratron

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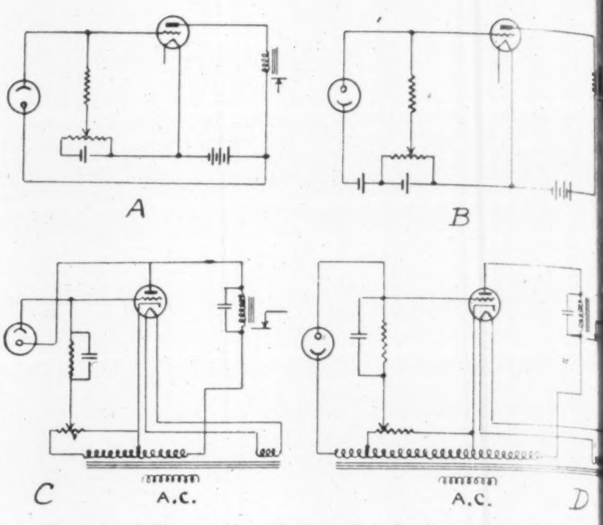

Fig. 218. Different types of phototube circuits.—*A* shows a forward circuit; *B* a reverse type of circuit; *C* a forward a-c. circuit; *D* is a reverse a-c. circuit.

tubes in phase control and trigger circuits for the contr of load current by light. Such a circuit is shown in Fi 219. Phototubes in circuits of this type are used as t variable resistance elements in the phase-shifting circuit A capacitor is used as the reactive element in the phas shifting circuit since only by means of a capacitor can suf ficient reactance be obtained in commercial frequencies match the high inherent resistance of the phototube.

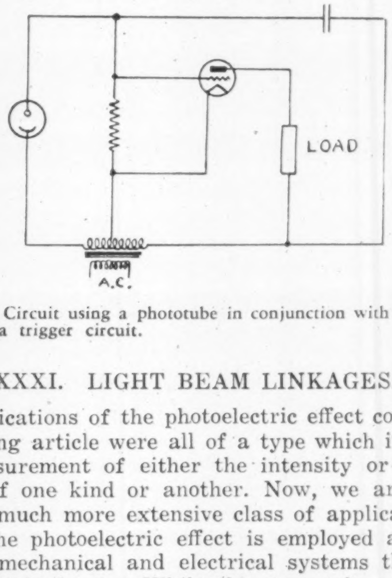

Fig. 219. Circuit using a phototube in conjunction with thyratron tubes in a trigger circuit.

XXXI. LIGHT BEAM LINKAGES.

The applications of the photoelectric effect considered i the preceding article were all of a type which involved th direct measurement of either the intensity or quality o radiation of one kind or another. Now, we are about t consider a much more extensive class of applications, tha in which the photoelectric effect is employed as a mean of linking mechanical and electrical systems through th agency of light beams. While this type of application i less fundamental, it is the one which has been found mos useful not only in the field of measurement but in indus trial control as well. In this class of applications, photo tubes and photocells perform such massive functions as re versing the travel of a red-hot 50-ton ingot of steel in rolling mill as easily as they check the accuracy of one' wrist-watch.

In this article a number of phototube and photocell ap plications will be described to show what can, and what ha been done, but the list must not be considered in any wa exhaustive. The field of phototube application, even in th branches devoted to instrumentation, is already so vas that even assuming space was available to describe all o them, such a list would not be complete, since by the tim it was finished many new uses would have been developed

In general, phototube applications can be grouped int two classes: first, those which would be impossible withou the use of tubes and, secondly, those in which tubes fulfil functions which might be done in other ways though per haps not as cheaply nor as well.

Photoelectric Bean Sorter

As an example of the first class—and this is not so much an instrumentation application as it is an industrial inspection application—consider the clever little device shown in Fig. 220 for sorting navy beans in a Micihgan food plant. Navy beans, whether you happen to be a connoisseur or not, must be white and perfect, not discolored or spotted in any way. It is said that a single discolored or imperfect bean in a traditional bean pot on a Saturday night is sufficient to throw a truly Boston household into the wildest consternation. So beans must be white and perfect and before the device shown in Fig. 220 was invented, girls used to sort beans by hand, from morning till night. The beans would come along on a conveying belt and the discolored ones would be removed as they passed by the girl inspectors. It was tedious work and, working all day, the girls sometimes earned as much as $1.25 a day. Now, thanks to the electron tube, this bean sorting is done automatically and the girls probably are in the WAC or WAVES or working in war plants.

The beans are placed in a hopper through the lower part of which the periphery of a hollow wheel passes as shown.

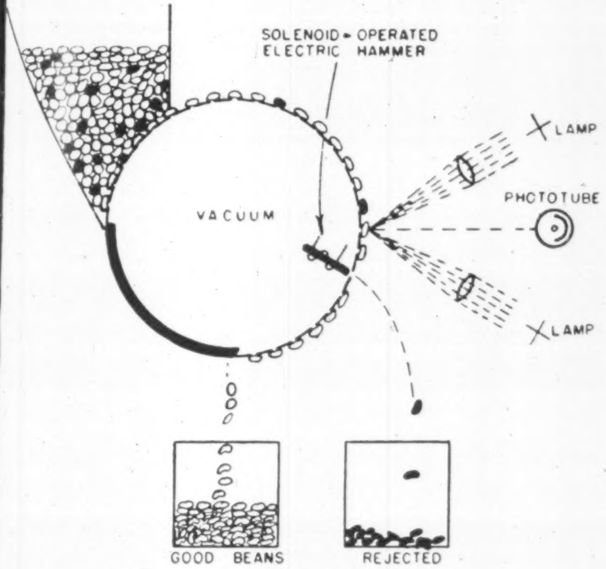

Fig. 220. An Electron-tube Navy beam sorter.

The periphery of this wheel is pierced with small holes and a vacuum is applied to the inside of the wheel so that in passing through the hopper, by virtue of the suction, a bean attaches itself to each opening. Part of the way round, a small section of the periphery is strongly illuminated by two lamps and as each bean passes under this illuminated spot the light is reflected from the surface of the bean into a phototube. As long as the bean is white and perfect nothing happens but if a discolored bean comes under the area scanned by the phototube, the phototube current varies and trips a relay. This relay energizes a small solenoid hammer which suddenly strikes the inside of the wheel and knocks the defective bean off. The action is very fast and there is just enough delay in the system as to place the discolored bean directly over the hammer when the blow is struck. Good beans are carried along to the lower part of the cycle where a close fitting shoe on the inside or outside of the wheel covers the ports, thus releasing the vacuum and the beans drop off.

When it is known that the number of discolored beans in the average bean crop runs between 7 and 20 percent, the usefulness of these sorting machines becomes more obvious.

This, it will be obvious, is an application of the electron tube that could not be accomplished in any other way because in the phototube we have for the first time a device which takes the place of the eye. Before the development of the phototube there was no practical device that would act as a substitute for the human eye in the control of

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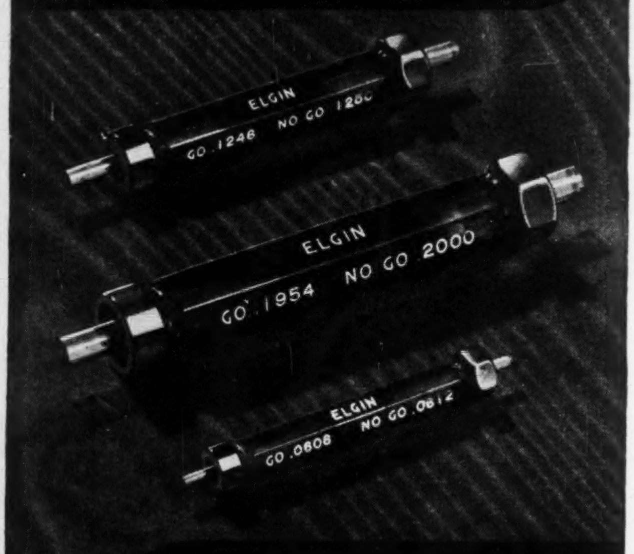

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industrial or mechanical operations of any type. The device, of course, also involves the use of amplifying tubes but the phototube is the basis of its action.

Value of The Optical Link

The phototube, in fact, is one of the most useful members of the electron tube family as far as industrial uses are concerned. The fact that it operates by means of a light beam which has no inertia enables it to initiate operations by objects which are not touched mechanically and this opens up a vast new field of action. It provides the industrial engineer with a new degree of freedom, one which enables him to couple the whole science of optics to his electrical and mechanical control problems. It gives him not only an inertialess arm or lever but also provides him with a device that responds both to the frequency and the intensity of the light; indeed, it goes further than that for it is sensitive in the ultra-violet region as well. The principal use in industrial work for phototubes and photocells, however, is to provide an optical link between a mechanical and an electrical system. An excellent example of this type of application was given in a preceding article where the speed of a centrifuge operating at 100,000 r.p.m. had to be measured. Here the high speed of response of the phototube coupled with the fact that it exerted no drag or load on the moving body made it an ideal solution to a difficult problem.

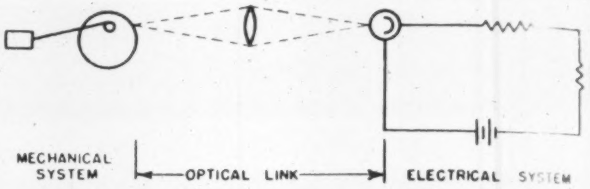

Fig. 221. The principal use of the photocell in industry is to provide an optical link between a mechanical and an electrical system.

In no field of application has the phototube been of greater value than in that of measurement. Those of us who ever had any occasion to make measurements with laboratory type mirror galvanometers may recall how sensitive they were and how fascinating it was to see the tiny spot of light dance across an extended scale sometimes halfway across the room. The inertialess pointer—the slender beam of reflected light from the mirror—somehow gave one a feeling of "control," of extension beyond the limits of mere matter. Such instruments are cumbersome and impractical for ordinary commercial use but, in the laboratory where delicate currents have to be measured or detected, the mirror galvanometer occupies a place that can be approached by few other instruments.

In this form of instrument a tiny silvered mirror attached to the moving system of the galvanometer reflects a beam of light on a scale set up some distance from the moving element as shown in Fig. 222. The greater the distance between the scale and the mirror, the greater the deflection of the spot of light across the scale for a given movement of the mirror. When this arrangement is used with a d'Arsonval or Einthoven movement, an extremely sensitive galvanometer is obtained. With the scale at

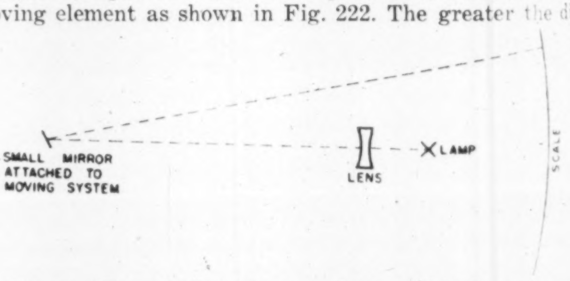

Fig. 222. The reflecting galvanometer uses a light beam as a pointer. A small mirror is mounted on the moving system of the instrument in such a way that it reflects the light from a lamp X onto an extended scale mounted some distance away from the moving element.

distance of one meter and with a d'Arsonval or Einthoven movement an order of sensitivity of 0.00001 microampere per millimeter deflection is obtained.

It is quite evident that the extreme sensitivity of the reflecting galvanometer is due in large measure to the multiplication of motion offered by a long lever arm. The same result could be obtained by a long pointer attached to the moving system as is done with a shorter pointer in the ordinary portable instrument, but any pointer however thin and light has weight and mass and exerts a drag on the system which rapidly decreases the sensitivity as the length is increased. But a beam of light has no weight and so provides all the advantages of a long pointer with none of its limitations. The beam of light acts as an amplifier of the motion of the mirror which, naturally, is very minute.

For ordinary commercial and power measurements the extreme sensitivity of the reflecting galvanometer is unnecessary and the d'Arsonval type of instrument provided with a pointer or some form of alternating current instrument with a pointer is adequate; millions of them are in use. The light tubular metal pointers used on these instruments exert negligible drag on the moving system.

In the case of recording instruments, however, the situation is not as simple as it is for indicating instruments. The usual direct-acting recorders used in power stations are merely the heavier and higher-torque counterparts of corresponding indicating instruments. When the electrical values to be measured are strong enough such recorders function entirely satisfactorily. They have highly desirable characteristics such as continuous record and rapid response but because of the power required to actuate the recording pen they cannot be made to approach indicating instruments in sensitivity. The moving of a pen across paper takes a great deal more power than is available in the coils or circuits of ordinary indicating instruments. The friction of a pen across paper is from 100 to 1000 times as great as the friction in jeweled movement bearings. Thus, while indicating instruments of the microampere class have been available for many years, conventional recorders, exemplified by the d'Arsonval type of instrument, have been available only in the milliampere class. Obviously, for many purposes—cases where alternating or direct currents of lower power than it is possible to record by conventional recorders must be recorded—it is desirable to have a recorder that will have, say, the sensitivity of the reflecting galvanometer or even the standard microammeter or millivoltmeter coupled with the recording feature of the standard recorder.

The electron tube has made such recorders possible and in this article we will describe two types operating on different principles.

Electron Tube Recorders

Naturally, the use of electron-tube amplifiers is one of the first thoughts that comes to mind in a consideration such as this and it might be assumed that all we have to do is to amplify the weak signals to a point where sufficient power is available to actuate a recording pen.

The solution to the problem is not quite as simple as this, however. In many cases when such methods are studied, it is found that they possess certain inherent limitations which cannot be disposed of. It is, for example, difficult to amplify weak direct currents, so a method which might be feasible for use with alternating current could not be used with direct current. In other cases, the effects of ambient temperature or the necessity for skilled maintenance would prove detrimental. The two methods described in the following paragraphs, however, have none of these limitations.

The first method is a purely electrical method while the second is an electro-optical method involving the use of an intermediate optical system and photocells.

The first recorder, which is one developed and marketed by the Westinghouse Electric & Manufacturing Co., depends for its action on an additional coil mounted on the moving element of the measuring instrument. This coil does not add any appreciable work for the measuring element

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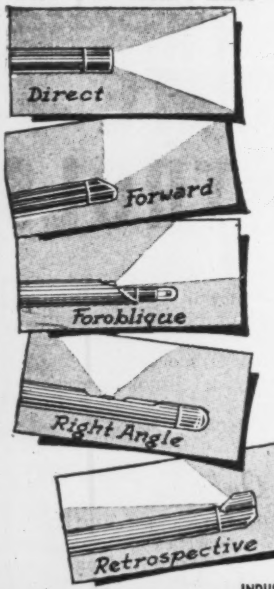

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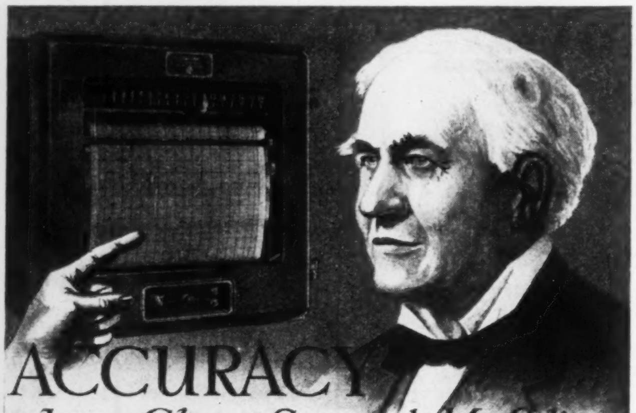

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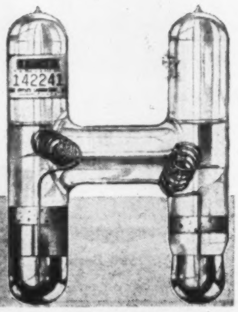

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to perform; therefore, the accuracy or the torque requirement is not changed. The coil is used as a detecting or pilot coil and is placed in the field of a stationary a-c electro-magnet. The object of the pilot coil is to detect the position of the measuring element with respect to the electromagnet. A duplicate of this coil is mounted on the recording mechanism and arranged to operate in the field of a similar electromagnet excited from the same a-c source. The relative position of these pilot coils is compared and controlled by their relative action on an auxiliary circuit. The current in this auxiliary circuit is amplified to give power sufficient to drive a high-torque pen-driving element. Photoelectric action, it will be noted, is not employed in this recorder.

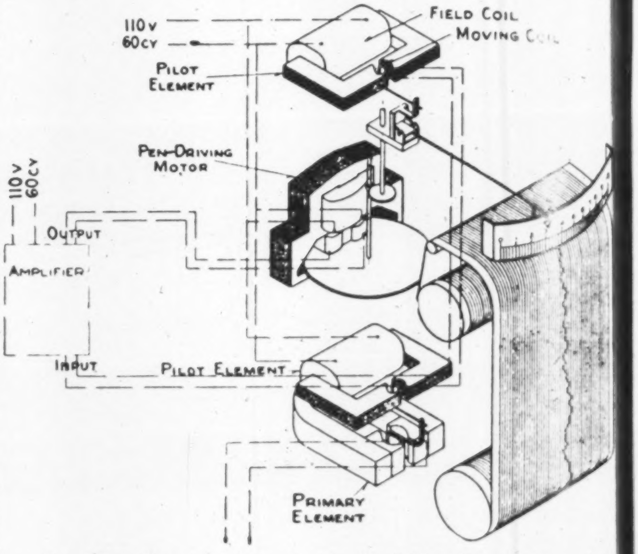


Fig. 223. Schematic diagram of the Westinghouse electronic recorder.

A diagram of this electronic recorder is shown in Fig. 223. The primary element, which may be any electrical instrument mechanism or measuring mechanism whose position depends upon the value being measured, is mechanically connected to a pilot element which comprises a moving coil mechanism rotatable in an a-c. field. The moving coil of this pilot element is connected in series with the moving coil of the duplicate pilot element which is mechanically connected to the pen-driving motor as shown in the schematic diagram. The moving coils of the pilot elements are connected in series opposing each other. The stationary fields of both pilot elements are connected in parallel to the same a-c. source as shown.

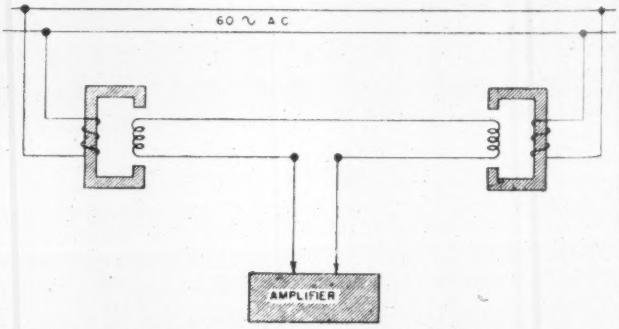


Fig. 224. A simplified diagram of the pilot coil connections in the Westinghouse electronic recorder.

When the two pilot coils do not occupy the same relative positions in the a-c. fields, the voltages induced in the coils are not equal so that the output voltage is of a value depending upon this difference of position. This voltage is of the order of 50 millivolts per degree deflection. When the two coils occupy the same relative positions, their volt-

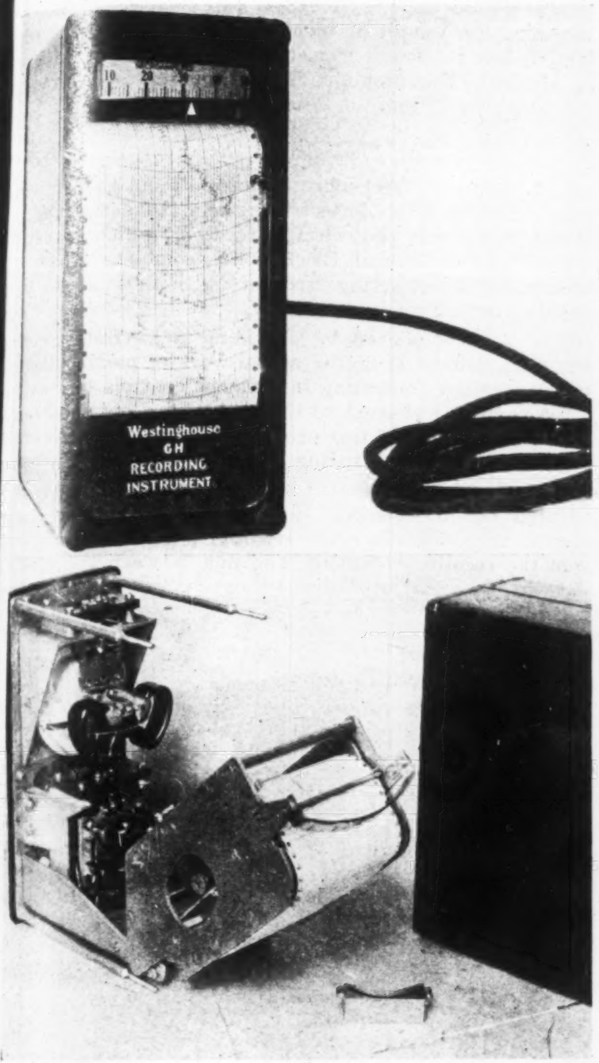


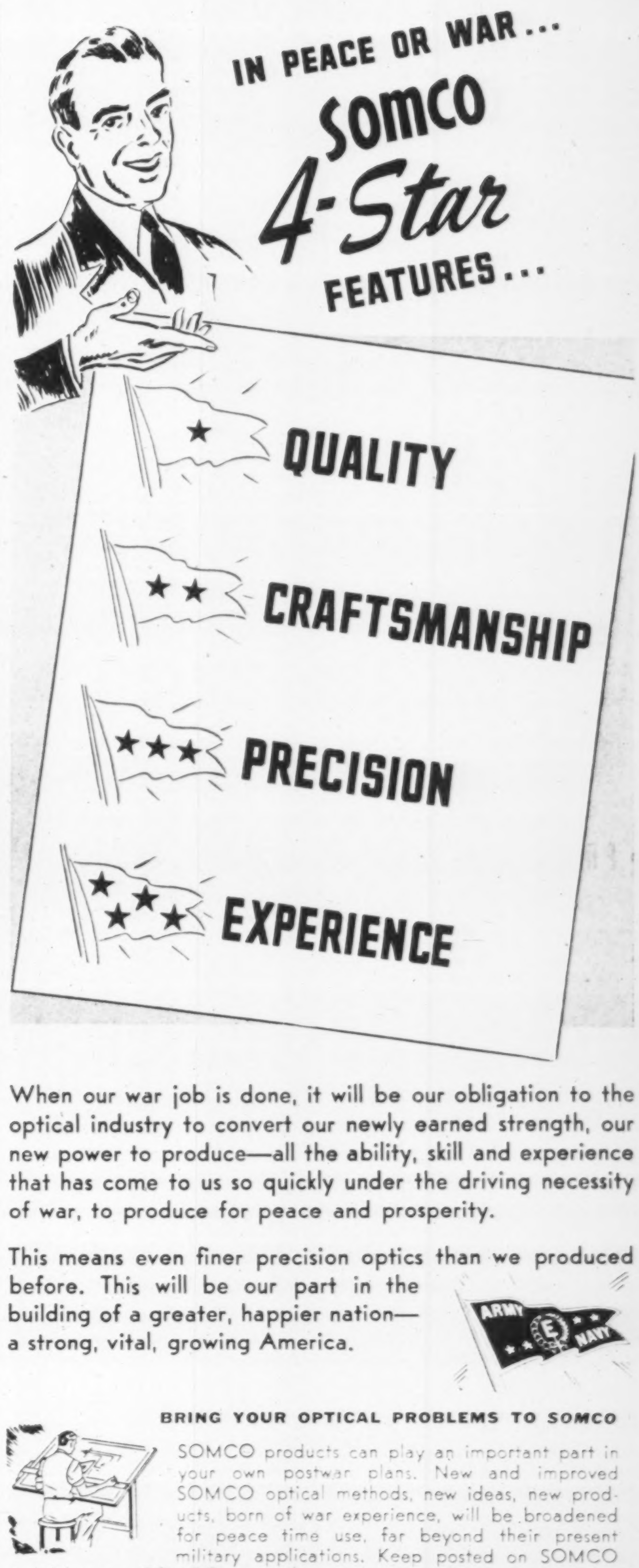
Fig. 225. The Westinghouse electronic recorder.

ages being equal and in opposition, no voltage is available at the terminals. The output of these coils is connected to the grid of the amplifier tubes of the power amplifier unit. The principle involved may be seen perhaps somewhat more clearly from the simplified diagram in Fig. 224. The a-c. output of the power amplifier is of the same frequency as the pilot element excitation.

The pen-driving element is essentially a 2-phase motor of which one phase is continually energized from the same source of power as the pilot electromagnet coils. The other phase is energized by the output of the electron-tube power amplifier. The polarity and value of the current in this phase of the motor with respect to that in the other phase, is, of course, determined by the relative positions of the pilot coils. With the second phase of the pen-driving motor connected to the amplifier output, the motor will turn in a clockwise or counterclockwise direction at a speed proportional to the difference in pilot coil positions. This results in a proportionate response action of the pen motor.

Thus, it will be obvious that the pen pilot element will always tend to set itself in a position to correspond with that of the primary pilot element. The pen motor turns in one direction or the other until the difference in pilot voltages is zero. It is, therefore, a "null" method. Since the speed of response is a function of the difference in pilot coil positions, anti-hunting or special damping devices are unnecessary.

This instrument will record d-c. millivolts and microamperes at energy levels of 4 or 5 microwatts. The torque of the recorder is 5 to 10 times that of a conventional direct-acting recorder and this greater torque is attained without



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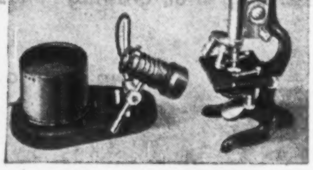

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increasing the weight or inertia of the pen driving mechanism, in fact the motor element is lighter than a direct acting element. The amplifier is, of course, a high-vacuum tube amplifier of more or less standard design.

The Photoelectric Recorder

Now, we will direct our attention to another recorder which involves a photoelectric system. Like the unit described above, this photoelectric recorder, which is that developed by the General Electric Co., combines all the advantages of direct-acting recorders with those of the most sensitive indicating instruments.

This is accomplished by providing a separately-excited recording element to do the actual work of making the record. A sensitive indicating instrument controls the position of the recording element so that the record obtained represents the readings of this primary element. The loss in the sensitive primary measuring instrument is only the power required from the measured circuit.

Unlike the first recorder described, the sensitive primary element in this photoelectric recorder is electrically isolated from the recording element. The link between the primary and recording elements consists of a combined optical system and photoelectric circuit. The primary element itself rotates a galvanometer mirror through an angle corresponding to its readings and can be even more sensitive than the usual indicating instrument with a pointer. On the other hand, the recording element may readily possess as much torque and be as heavy and sturdy as desired without affecting the basic element or measured circuit in any way. As will be shown, the two elements are entirely isolated except for an optical link.

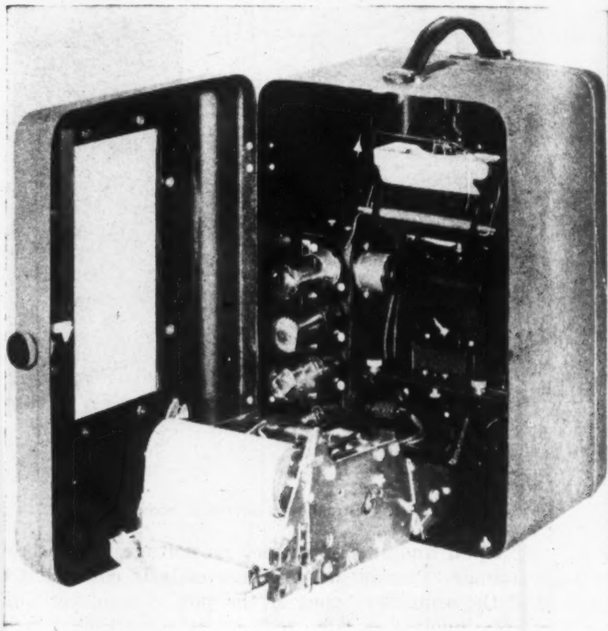

Fig. 226. The General Electric photoelectric recorder.

The primary instrument carries a galvanometer mirror, the deflection of this mirror in response to the measured value is the only mehcanical work the instrument is required to perform. By means of an optical system and an electron-tube circuit, a high-torque recording element is actuated so that it follows the primary instrument and records its readings. The power necessary to operate the recording element and the other parts of the recorder is obtained from an auxiliary source so that the losses in the primary instrument are the only losses which the measured circuit is required to supply. Thus the fundamental advantage of the photoelectric recorder lies in its ability to utilize the most sensitive indicating instruments and galvanometers as recorders with direct-acting recorders of conventional design.

Regardless of the type of basic instrument used, whether

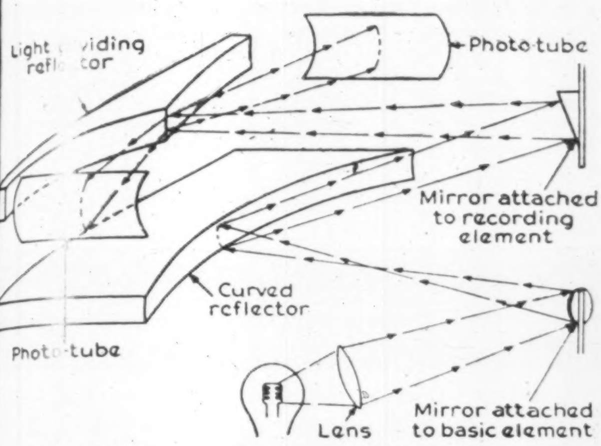
Light dividing reflector
Photo-tube
Mirror attached to recording element
Curved reflector
Photo-tube
Lens
Mirror attached to basic element

Fig. 227. The complete optical system of the General Electric photoelectric recorder.

a galvanometer or an indicator, it is arranged to deflect a small mirror in front of the lamp-housing lens tube.

There are two mirrors, the one just referred to attached to the basic instrument, the other attached to the recording instrument. A diagram of the complete optical system is shown in Fig. 227. The optical system is located between the two mirrors.

The light from the lamp after passing through a condensing lens falls on the primary-element mirror from which it is reflected to some point on the curved reflector depending upon the reading of the primary instrument. From the curved reflector, the light is reflected into the recording-element mirror and from there to the light-dividing reflector and then to the two phototubes. It is in the optical system that the light-ray connection between primary and recording elements ties up with the photoelectric circuit to cause the proper functioning of the recording element. The optical system accomplishes this by allowing an excess of light to fall upon one or the other of the phototubes when the recording and basic elements are not exactly in line. If the recording element is too far down scale, more light falls upon the phototube to the left and if it is too far up the scale, more light falls on the phototube to the right. When the recording and primary instrument elements are exactly in line, the light ray divides evenly between the two phototubes as shown in Fig. 228. In this illustration the mirrors are shown offset so that the vari-

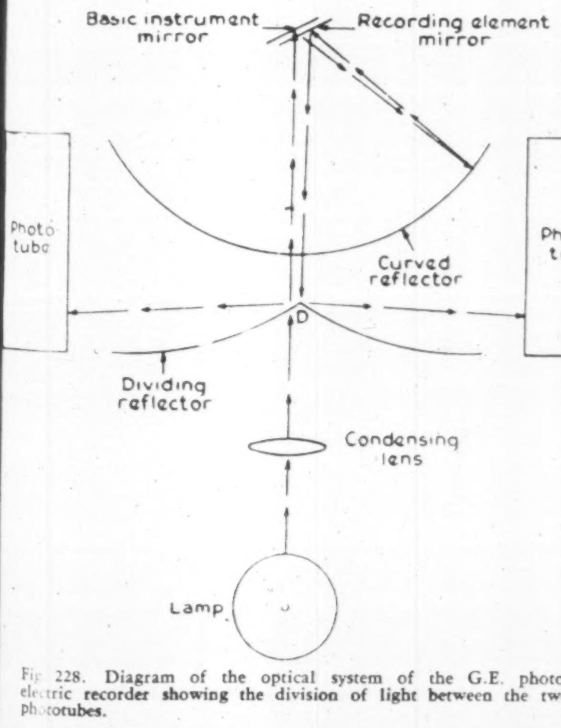

Fig. 228. Diagram of the optical system of the G.E. photoelectric recorder showing the division of light between the two phototubes.

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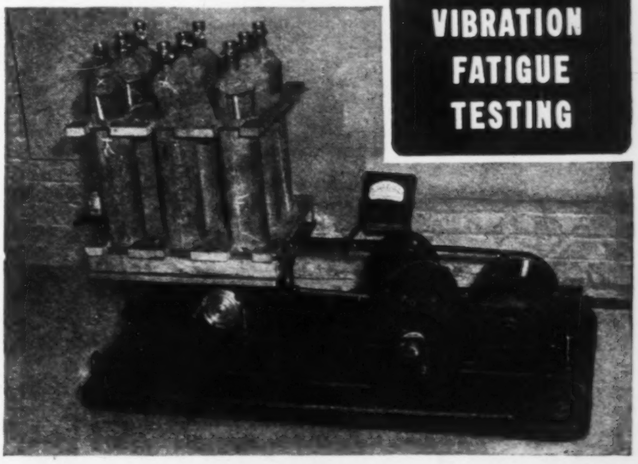

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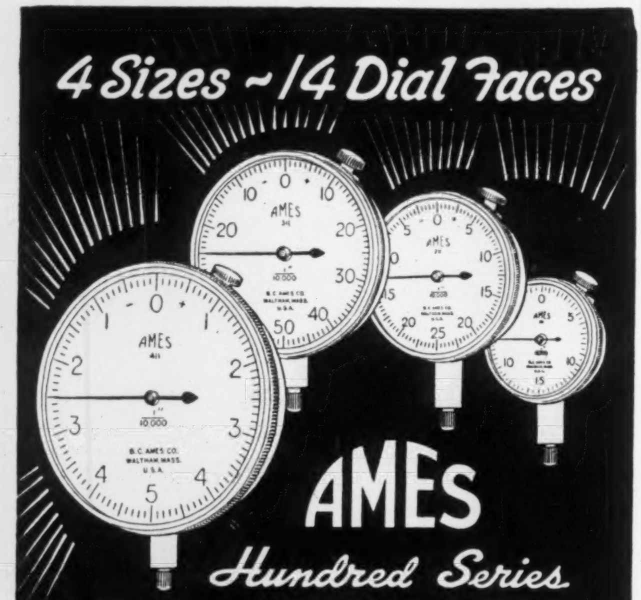

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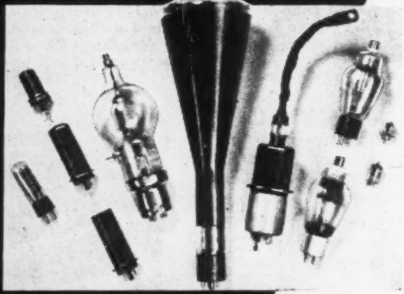

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ous angles of reflection can be traced. It will be noticed that regardless of the position of the basic instrument mirror, the light ray will come straight out toward "D" when the recording and basic instrument mirrors are parallel.

The photoelectric circuit through which the optical system operates the recording element is shown in Fig. 229. This circuit is composed of two 3-element vacuum tubes. One of these tubes operates as a rectifier with the grid permanently connected to its filament and the other operates as a control tube. The rectifier passes a constant half-wave direct current through the recording element in the direction necessary to force the recording pen down-scale. The control tube passes a similar current through the recording element in the direction necessary to force the pen up-scale. In the latter case the value of the tube current is determined by its grid potential, which in turn is controlled by the potential controlled by the phototubes.

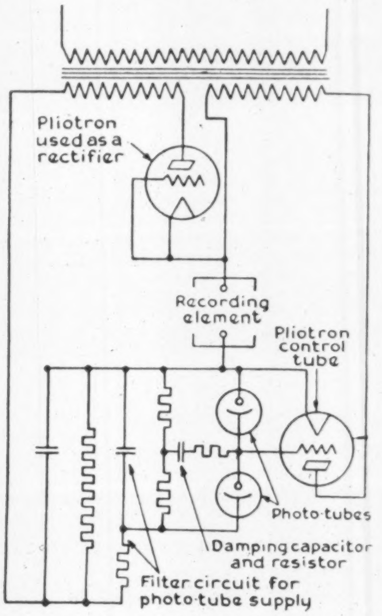
Pliotron used as a rectifier
Recording element
Pliotron control tube
Photo-tubes
Damping capacitor and resistor
Filter circuit for photo-tube supply

Fig. 229. Schematic diagram of connections of the G.E. photoelectric recorder.

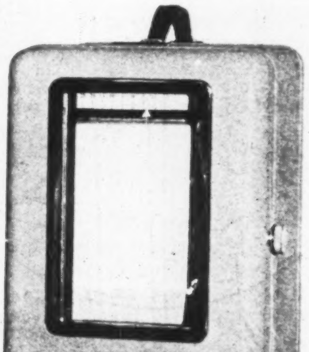

Fig. 230. The General Electric photoelectric recorder, complete in case. It resembles the ordinary direct-acting recorder but is often a million times more sensitive.

If the optical system indicates that the recording element should move down-scale, more light is caused to fall on the lower phototube in Fig. 229 which swings the grid voltage in the negative direction. This decreases the current through the control tube, allowing the rectifier current to come into effect and move the recording element in that direction. If it is necessary to move the recording element up-scale, the opposite action takes place. When the recording pen is in the correct position, the phototubes adjust the current in the control tube so that it balances the current from the rectifier and there is no motion of the recording element.

In addition to supplying the current necessary to operate the recording element in the down-scale direction, the rectifier tube also provides a source of voltage to operate the phototubes. This voltage, as obtained across the series resistance, is of course, half-wave direct current. The resulting pulsating potential drop is filtered before application to the phototubes by means of the capacitance and series resistance which is connected across the resistor.

It will be quite obvious that the sensitivity of this recorder is dependent only upon the sensitivity of the basic element. Rapidity of response is usually governed by the period of the basic element, although in some isolated cases the period of the recording element may become the limiting factor.

The highest sensitivities first obtained in frequency records with this recorder were greater than are justified by present central station practice. In frequency recorders a scale range of one to two cycles has been found quite practicable. Voltage recording has been accurately accomplished with a chart scale range of 4 or 5 volts on a 115-volt circuit.

Perhaps the greatest advance, however, has been obtained in low-reading microammeters. Several recording microammeters have been constructed with a full-scale current of less than one microampere. At full scale, such recorders draw less than 0.001 microwatt from their measured circuit* Their operation is better in many respects than direct-acting recorders requiring many millions of times more power.

A knowledge of the action and sensitivity of this recorder gives one an appreciation of the marvelous power of the electron tube in extending the field of action of existing instruments. Taking no power at all from the primary measuring instrument, it nevertheless multiplies the power of this basic instrument millions and millions of times. In the case of the recorder the object is the movement of a recording pen over a moving chart, but by the use of other amplifier tubes the primary element could just as readily cause the movement of a steel girder weighing many tons if that should ever prove necessary.

The application of the phototube just described is a relatively complicated one, involving as it does delicate moving mirrors and carefully adjusted optical balances. Many applications are of a more simple nature.

Simple Temperature Controller

Consider, for example, a simple temperature controller such as shown in Fig. 231. Here a phototube is used in conjunction with an ordinary glass thermometer. A light source and lens is mounted on one side of the thermometer and the phototube on the other side, at a level corresponding to the desired temperature. If the mercury column falls below a certain critical level, the light falling on the photocathode surface increases, causing the amplifier tube plate current to actuate a relay which closes a heater circuit. As the heat comes on, the mercury in the thermometer rises and intercepts the light beam, thus cutting off the heat.

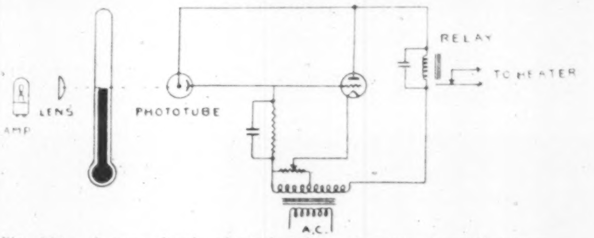

Fig. 231. A very simple photoelectric temperature control system.

This simple method of temperature control leads to a

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* Editor's Note.—A *millionth* of a microwatt full-scale deflection is obtained in some of these G.E. photoelectric recorders used by Armed Forces doctors in nerve-action studies.—MFB

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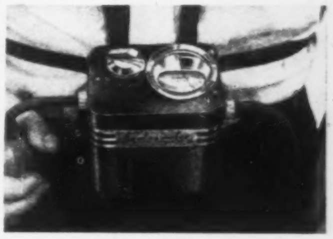

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somewhat similar method of using phototubes but one which is applicable to the control of other conditions than temperature. Fundamentally, this method is almost absurdly simple and while not as accurate or rapid as certain other methods it is exceedingly useful and it has been applied in a number of commercial control devices.

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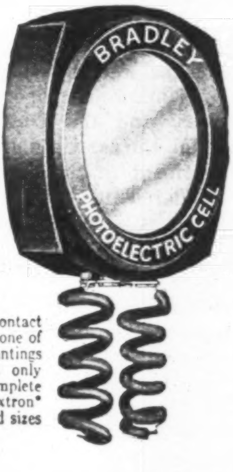

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FLUID DIRECTION METHOD

Continued from page 740

bridge circuit could serve both as sources of heat and as temperature-sensitive elements.

The tube itself, if made of metal, can be used as one element of a thermocouple. The whole device is simple in principle; may be ruggedly built; is extremely sensitive to and responds quickly to changes in direction.

Possible applications are numerous. Combined with other instruments it may be used as a wind-direction indicator, as a safety device to detect reversal of flow, and in automatic control systems to operate valves or dampers, or to keep something oriented properly with respect to a fluid stream.

This method should have several uses in wind tunnel experiments. Appropriately applied, the principle of the device can be used to indicate *direction* of pressure across an air foil. Also, there is the possibility of using the device as an accessory instrument to aid in determining the drift of airplanes. Another imaginable application is the use of the instrument in connection with a magnetic compass and radio apparatus in balloon soundings to determine wind direction in the upper atmosphere.

The device, of course, is not a detector of *absolute* motion. It is, however, an extremely sensitive detector of relative motion; and because of the electrical principle employed it may conveniently be incorporated in electric circuits with other instruments.

It would be necessary to proportion the various parts of the device for a given application. Permissible galvanometer sensitivity would, as a rule, determine the necessary temperature difference between thermocouple junctions, which, in turn, would be determined by both the quantity of fluid flowing through and over the tube and the heat supplied at the mid-point of the tube. However, none of these adjustments is critical. In some applications ambient heat from external sources may be sufficient to enable the device to operate satisfactorily without the direct application of heat.

For the author's own experiments forty detectors were used, each made up in the form of a cross as shown in Fig. 1. The purpose was to obtain the direction of air currents and to locate turbulent and stagnant areas in only one plane of the room, namely, a plane parallel to a selected direction of the wind. This information was desired to supplement temperature and relative humidity surveys made in the same plane.

The cross was composed of ½″ brass tubes and measured 2½″ overall. The heater consisted of 12″ of No. 32 gage enameled alloy wire wound into a small coil and fixed inside the tubes at the center of the cross. All heaters were connected in parallel and then through a rheostat to a 6-volt transformer. Separate leads for each thermocouple ran

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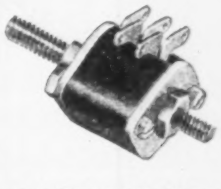

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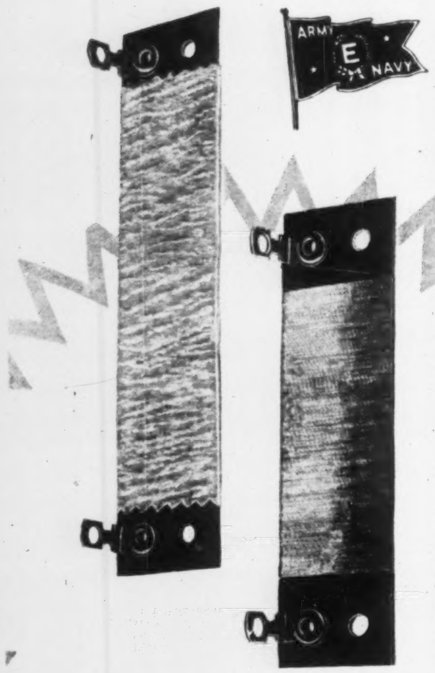

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to a switchboard located outside the room.

The detectors were mounted at four-foot intervals vertically and horizontally. The mounting was such that each instrument could be turned through an angle of 90 degrees by means of a handwheel situated near the switchboard.

One instrument was read at a time. The procedure consisted of rotating th handwheel and watching the galvanometer, thus "feeling" for a balanced position. The position of the detector wa read from a dial laid off in degrees o angular displacement. The direction indicated by each instrument was the transferred to a chart upon whic streamlines were sketched by eye.

Instruments in the War Effort

Muzzle-velocity Calibration Teams

ARMY ORDNANCE calibration teams in Italy and Germany are employing new ballistic measuring instruments to increase the accuracy and to extend the battle usefulness of American heavy artillery. The new equipment, which can be installed in a 2½-ton Army truck and transported right up to the battlefront, is capable of measuring the speed of projectiles within 0.00001 sec.

It is always a difficult problem to get a projectile squarely on the target at ranges up to 17 miles. Involved in this operation are such factors as the age of the gun, the quality of the ammunition, the curvature of the earth, and such additional factors as wind, temperature and barometric pressure. These constantly-changing factors necessitate complex mathematical calculations and the use of the most modern scientific devices in order that the highest degree of firing accuracy may be obtained.

A recent Ordnance scientific mission, headed by Colonel Leslie E. Simon, Chief of the Ballistic Research Laboratory, Aberdeen, Maryland, traveled 160 miles with Lieutenant Mark Clark's Fifth Army in Italy and, later set up their mobile equipment on the western European battlefront where they actually calibrated guns that were being fired on enemy targets.

Colonel Simon's team calibrated all types of heavy artillery weapons. The problem was to determine the velocity of projectiles of guns and howitzers that had been in service for several weeks or months, as compared with the velocity of new artillery pieces in action for the first time. Old guns and howitzers cannot shoot as far as new weapons. Obviously, when guns of different ages are being fired together in battery at the same target, allowances have to be made for each used gun. Experts of the Ordnance Department, Army Service Forces, not only calibrated front line batteries in Italy and western Europe but also trained calibration teams to carry on this highly important activity.

This scientific work demonstrated that the life of gun tubes is much longer than previously assumed. Gun crews, in the past, discarded gun tubes rather frequently because they had no way of knowing the maximum efficient life of a tube and could not afford to tak chances when the lives of our Infantrymen were at stake. Today's instrument give them this knowledge and reduc considerably the artillery supply problem.

At the present time, seven Ordnanc calibration teams are at work on th various battlefronts.

War's Smallest Component

FINE resistance wire, made of 80% nickel and 20% chromium, is a modern triumph of coöperation between industry and the United States Army Signal Corps. Used in communications equipment in the hottest battles, it i considered to be "the smallest component of war." Its diameter is as small as 0.0008" (about one-fourth the diameter of an average human hair). Fo insulation it is treated with three t six coats of enamel which is baked o in successive operations.

Ninety miles of wire, (475,000 feet) can be produced from a pound of th nickel-chromium alloy. The finest-drawn nickel-chromium wire, used for precision resistors, will handle up to tw watts in radio receivers and has a resistance of 650 ohms per circular mi foot.

Several manufacturers in different sections of the country are producing wire of this alloy, and the output will be stepped up substantially as new uses for it are developed. The smallest component of war represents another forword step in the Signal Corps' constant battle to produce better instruments of war with less critical material in fewer hours of labor.

Instrument for Testing Airworthiness of Fabrics

A TEST and calibration program has been conducted by the National Bureau of Standards on a new mechanical fabric tester developed by the Civil Aeronautics Administration. This work has resulted in the refinement of the instrument, which determines the airworthiness of doped fabric aircraft covering. It is expected that this mechanical method will supplant the method in which the inspector judges airworthiness by his ability to push his thumb through the fabric.

The instrument operates on the same

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principle as the automatic center punch. The foot of the instrument is held against the surface to be tested and a steadily increasing pressure is applied, thus compressing a "firing" spring. When the spring has been compressed a predetermined amount, it is released by an automatic trigger and drives a hammer against a plunger which impinges upon the surface being tested. The energy of impact is obtained by measuring the indentations produced in a block of lead.

Maintenance of Radiation Standards

Thirty years ago the radiometry section of the National Bureau of Standards established a standard of thermal radiation in the form of a 40-watt 115-volt carbon-filament lamp calibrated against a blackbody, for use in standardizing thermopiles and other nonselective radiometers employed in measuring weak sources of radiation. The demand for these lamps has exceeded expectations: more than 300 of them have been issued during the past 25 years.

Recently the section prepared a more powerful standard source of thermal radiation in the form of a 1,000-watt monoplane tungsten-filament lamp for use in calibrating similar high-powered lamps that serve as the working standards of manufacturers of "infrared-ray" drying lamps extensively used in industry. These high-powered radiation standards were recently recalibrated and placed on a more reliable basis; also some of the 40-watt standards (the Bureau has a group of 33 of these lamps that are used to maintain the standard) were checked by W. W. Coblentz and C. J. Humphreys.

In addition to these two standards of thermal radiation, the section maintains: (1) a "cold quartz" mercury-arc standard for calibrating ultraviolet-intensity meters used in measuring the output of ultraviolet germicidal lamps for disinfecting the air in hospitals, etc.; and (2) a "hot quartz" mercury-arc lamp standard for calibrating dosage intensity meters that are used to measure the output of ultraviolet therapeutic lamps.

The Bureau was the pioneer in establishing a standard of radiation, which has formed the nucleus for similar standards maintained in the national laboratories of various countries.

R-f. Thermocouples Standardized

The American Standards Association has announced approval of the new American War Standard, Dimensions for External Radio-frequency Thermocouple Converters (120 milliamperes to 10 amperes, inclusive) (C39.4-1943), formulated for the purpose of facilitating the production of external radio-frequency thermocouple converters and the equipment in which they are used. These converters will be interchangeable for use with r-f. currents from 120 milliamperes to 10 amperes, inclusive.

It is expected that this standard will be used by the Armed Forces in the design of new equipment and for replacement parts wherever possible. Designers of equipment should utilize this standard as extensively as possible and the standard should be controlling in the preparation of new manufacturing facilities. It will aid maximum production and simplify the repairs of equipment in the field.

Thermocouple converters covered by this standard are being manufactured widely and form part of the radio installations in every transport and bomber used today. It has been estimated that this standard covers 90% of the thermocouple converters used in radio and electronic equipment. Although there are additional styles of thermocouple converters now in use by the Armed Forces, which are not covered by this standard, it is not intended that their manufacture be immediately discontinued.

This War Standard may be obtained for 10 cents a copy from the American Standards Association, 29 West 39th St., New York 18, N. Y.

Instruments' Book Shelf

MANUAL OF LABORATORY GLASS-BLOWING. By R. H. WRIGHT. Chemical Publishing Co., Brooklyn, N. Y., 1943. Cloth, 5¾ × 8¾ inches, ix + 90 pages. Price $2.50.

Stating in his introduction that "Laboratory glass-blowing like most arts, tends to change its objectives and *methods* [italics mine] in response to changing demands on its practitioners and changing resources open to them," the author proceeds to tell how he blows glass.

Before going into actual technique he devotes some time to the materials and tools of the craft. A chapter devoted to "Glass" encompasses not only the physics of stress and strain in glass, and hence the need for annealing, but also pertinent data on the chemical compositions and individual idiosyncracies of the several types of glasses.

The chapter on "Glass Burners" goes quite deeply into the physics of combustion and the philosophy of burner design which results from the physical requirements. In his explanation of the reasons for the grid in the Meeker type burner he has overlooked one important function, which is to produce a large number of small Bunsen cones with consequent broadening of the area of high temperature. Composition and thermal properties of several commonly-encountered gases are well examined.

Under "Tools" are discussed most of those commonly met, yet the valuable didymium glass goggles for straining out the sodium flare, seem to have been forgotten. The blowing tube is a most potent item in the author's arsenal of tools. In fact, his reliance on it is evident throughout the greater part of his discussion of technique. Use of such a tube in the simple task of sealing together two small tubes of identical diameter seems not only to be carrying gadgetry a bit too far, but actually imposes a handicap on the operator. The weight of the tube and its general cumbersome nature combine, at least in this case, to make a simple job more complex. A valuable addition to the tool chest would be a set of glass-blower's rollers.

With full knowledge of the fact that this book is primarily an exposition of how this practitioner's technique has departed from the orthodox "in response to changing demands . . .," it still would be reasonable to expect that some of the orthodox techniques would receive attention. "Fundamental Operations" is innocent of any mention of the basic operations of "pulling a working handle" which is the key to quality in so many manipulations. Likewise, while Plate II illustrates four ways to grasp a pair of tubes, that employed by skilled glass-blowers, and for good reasons, is not noted. This latter is apparently due to a too-slavish attachment to the blowing tube.

In sealing together a pair of tubes, the skilled worker is likely to prepare the tubes by closing the ends in the flame and then blowing out a bulb which is broken off. This avoids the pin-holes which the author tells how to close.

Only in sealing the larger sizes of tubing would the technique of working but a small portion of the joint at a time, as here described, be employed. If a pair of working ends is first pulled, the two tubes properly held in the flame, and the blowing done directly rather than via blowing tube, a smooth and workmanlike overall joint can be made with but average skill.

Under "More Advanced Operations," bulbs, ring-seals, flares and the like are treated and then step-by-step procedures in such typical cases as condensers, vacuum jackets, and McCleod gages are outlined.

"Some Special Operations" describes sealing-in of wires, arc welding of platinum, graded seals, and ground joints.

The illustrations, both photographs and drawings, are helpful. The photographs, moreover, prove that glass can be fabricated by the techniques propounded.

—WM. B. WARREN

POWER AND FLIGHT. By ASSEN JORDANOFF. Harper & Brothers, New York, 1944. Cloth, 7¼ × 9¾ inches, 314 pages, price $3.50.

This book is about power FOR flight. It is a popularly-written description of motive power for aircraft. It includes a short chapter on the early history of powered flight, one on the various types of internal combustion engines, and a series of 17 chapters on the modern aircraft engine, its performance, its components, and its accessories. The engine itself and the associated systems for fuel supply, carburetion and supercharging, ignition, electric power, lubrication, starting, and control (including instrumentation) are described in some detail, with clear, simple but only elementary explanation of their functioning.

The various types of controllable propellers are described, also some engine-driven accessories such as pumps and generators.

The last eight chapters describe the disassembly, overhaul, cleaning, inspection and assembly of a typical aircraft engine.

The only aircraft instruments described are the engine instruments—fuel quantity gages, manifold pressure gages, engine, oil and air temperature indicators, etc.; and test instruments. These are treated briefly, so that the book is of interest to instrument men mainly for its general information on the power plant.

There are 310 illustrations, most of them excellent line drawings by Elizabeth Paige. The book is interestingly written, and most people not specialists in power plants will learn much from reading it.

One interesting point in the first chapter is that the Manly 52-hp. engine used in the unsuccessful Langley "Aerodrome" in 1903 weighed only 125 lbs., whereas the Wright brothers' 12-hp. engine used in their successful flight weighed nearly 200 lbs.

The reader should be warned that Chapter II, "What You Should Know About Power," has a couple of nonsensical examples of "atomic power" computations. On page 19 the author indicates a knowledge of Einstein's formula $E = mc^2$ for the energy equivalent of mass—theoretically the energy available if matter could be transformed into energy. But on page 20, in computing the energy released by transformation of hydrogen into helium, with partial loss of mass, this formula is not used. Instead, the energy is "calculated" from the lost mass and the velocity of electrons in the atom by the kinetic energy formula $E = \frac{1}{2} mv^2$, but there is no explanation of what connection, if any, there is between the LOST mass and the REMAINING electrons. To further compound the confusion, the author gives a result smaller than the indicated numerical computation should give by a factor of 32.2, and expresses the result in "ft./lbs. per second"! The energy in ft.-lb. as computed from the proper equation would be nearly 300 times larger than the figure given. Also on page 19, energy is given in terms of "horsepowers-per-second"!

The fundamentals are given in better fashion in Chapter IV, "What is Horsepower" (although the formula for BMEP on p. 45 is incorrect). However, the few equations can all be skipped without harm, since the book is essentially descriptive.

Only two or three other slight errors were noticed, and the general expression of the book is very favorable.

—W. A. WILDHACK, *Aeronautic Instruments Section, National Bureau of Standards, Washington.*

THEORY AND DESIGN OF VALVE OSCILLATORS. By H. A. THOMAS. Chapman and Hall, Ltd., London, 1939. Cloth, 5½ × 9 inches, 270 pages. Price [illegible]s.

This treatise is a valuable book. But it is not, as the title purports, a monograph on the theory and design of valve (electron tube) oscillators. A glance at the list of contents conveys this impression, which is confirmed upon closer review. The list of chapters is as follows:

I. Fundamental Principles of Self-oscillation in Valve-maintained Systems. II. Types of Oscillators and Conditions for Maintaining Oscillation. III. Amplitude and Wave Form of Oscillatory Current and Efficiency of Oscillators. IV. Frequency of Oscillation and its Dependence on the Maintaining System. V. The Frequency Drift of Oscillators. VI. Frequency Changes Due to Effects of Temperature on Inductance Coils. VII. Frequency Changes Due to Effects of Temperature on Condensers. VIII. Frequency Stabilization of Maintaining System. IX. The Stabilization of Inductance. X. The Stabilization of Capacitance. XI. Frequency Stabilization by Automatic Monitoring.

From chapter V, "The Frequency Drift of Oscillators starting on page 103, to the end of Ch. X, "The Stabilization of Capacitance" on page 241, the book is devoted exclusively to details of the stability of electric circuit elements, particularly at high frequencies. With a total of only 260 text pages in the book, considerations of circuit element stability are taken up at greater length than all other subjects.

True, these considerations are of great importance now, when the stability of capacitances, inductances, etc., despite changes of temperature, frequency, etc., is a critical matter in view of recent developments in FM, television, aircraft radio, etc. True, with regard to stability of circuit elements the author has both surveyed the field thoroughly and added richly from a vast store of experimental work of his own.

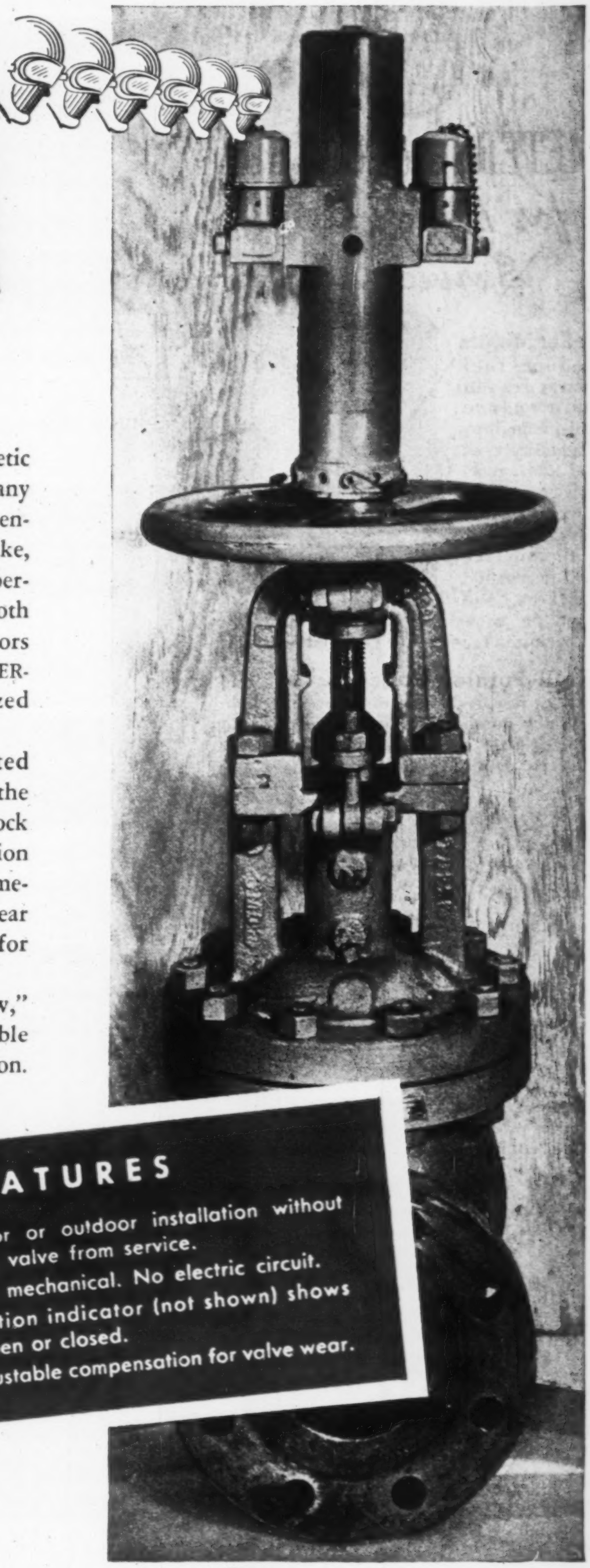
But the author, a specialist in this field, went on the mistaken notion (stated in his introduction) that, since with stability of the circuit elements assured, a stable oscillator could be achieved, all interest in the field of oscillators was to be focused on stabilizing the circuit elements. This is the "let-everything-else-go" fallacy a specialist is prone to fall into.

A fundamental insight into the subject of oscillators requires, to begin with, the broad perception that the oscillator is a shock-excited tuned element, the shocks being repeated regularly until a sustained oscillation is built up. From that perception it is readily seen that oscillations are developed through a building-up process. And if one knows the particulars of that process it can be learned what the transients will be; what will be the limiting factors as to amplitude, frequency, stability, etc.

These matters—the fundamental nature of the oscillation-generating process—the author has dealt with skimpily, where at all. The work of such men as E. L. Chaffee on the process of building-up of oscillations at the longer waves, of Holman and Barkhausen, on the electronic phenomena in short-wave generating—to mention only work that appeared in the *I.R.E. Proceedings* alone—all that work is not only untouched on in the text, but is even left out entirely from the bibliography!

The whole field of oscillators is replete with many complex, interesting phenomena, each rich with applications and uses: the generation of oscillations by electronic (Barkhausen-Kurtz) phenomena; by magnetron action; by mechanical coupling elements (crystal oscillators, magnetostriction oscillators); by untuned-element (discharge) action (multivibrator), etc. The stability of electric circuit elements is but one facet of this rich, extensive, and elaborate field. A treatment merely of the considerations for the stability of circuit elements in an oscillator cannot justly aspire to being a monograph on the "Theory and Design of Valve Oscillators."

—H. OLKEN, *Washington, D. C.*



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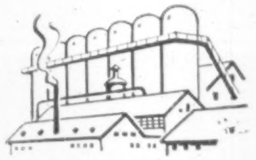

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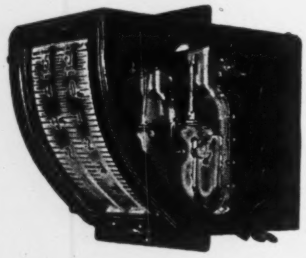
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The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. When writing to manufacturers directly, please mention this department. Or write to Information Section, Instruments Publishing Company.

Time Program Potentiometer Controller

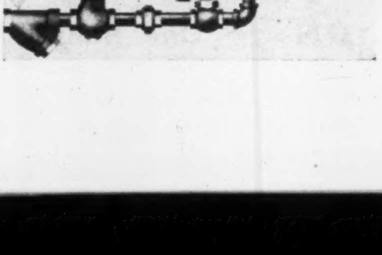
New "Time-Program Control" is available on maker's "Model 431 Pyromaster" potentiometer pyrometer described in *Instruments,* July 1937, page 172. Resultant time-program controllers automatically carry temperature through a predetermined series of changing values. Blank metal cams with time and temperature graduations printed on cam face enable user to cut his own cams with a pair of tin snips. Controller can be any of maker's five air-operated types or several electric types, in ranges up to 3000°F. for thermocouple type controllers and up to 3600°F. when used in connection with maker's compensated radiation unit.—*The Bristol Co., Waterbury 91, Conn.*

Thermostats and Humidistats

New enclosed models of "Visual-Stat" (see *Instruments,* May 1940, page 117) are for control of temperature or humidity, or both, in ducts, etc. Now used on military radio transmitters, etc., they will be available to industry after the war.—*Philadelphia Thermometer Co., Sixth & Cayuga Sts., Philadelphia, Penna.*

Steam-mixer Water-heater

New O'Brien Steam Mixer Water Heater is a complete packaged unit, including heater, temperature regulator, temperature-pressure relief valve, thermometer and, where necessary or desired, water pressure regulator and steam and water pressure gages. It employs a new muffler-diffuser type mixing nozzle, whereby not only is all the heat of the steam delivered to the water, but the condensate itself is utilized as hot water. Unit is designed for steam pressure of 50 to 150 lbs./in.^{2}; can be easily installed near point of use to deliver hot water at controlled temperatures. Steam pipe sizes range from ½" to 1½", with capacities ranging up to 5500 g.p.h. A wide selection of temperature ranges is available.—*O'Brien Steam Specialty Co., Dept. 40, 205 Harrison St., Syracuse 2, N. Y.*

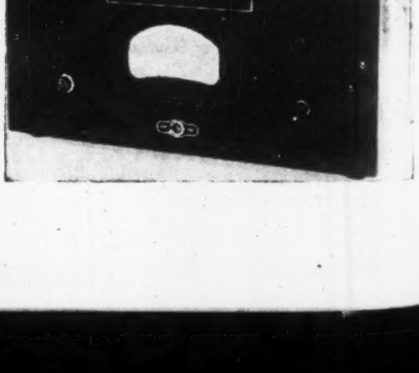


Redesigned Relays

New models of "H-B Mercury Plunger Relay" (*Instruments,* May 1938, page 129; March 1942, page 64; Oct. 1943, page 647) embodying two new refinements: A new crown-shaped wire guide incorporated as a part of the plunger keeps the plunger upright and friction-free, which results in a faster cleaner break with no chance for mercury splash or a prolonged arc. In addition, the arc is now broken over a new hardened ceramic material which eliminates powdering, thus still further prolonging service life, it is said. These new H-B Mercury Plunger relays are of the normally-open series, available for a.c. up to 440 volts and for d.c. to 250 volts, with contact capacities as high as 30 amperes. All have hermetically-sealed mercury-to-mercury contacts which are said to be positive, chatterless, noiseless, with no exposed arc.—*H-B Electric Co., 6110 North 21st St., Philadelphia 38, Pa.*

Millisecond-scale Elapsed-time Meter

New "Type MM100 Elapsed Milli-Seconds Meter" measures elapsed time directly in milliseconds on a linear-scale indicator. Start and finish of interval to be measured



initiate and terminate operation of unit by various mechanical, electrical or photoelectric means. Start of interval causes indicator to rise and termination stops indicator which remains in position for reading. Applications include measuring the operating time of relays, circuit breakers, fuses, etc. One Navy application provides a check on interval between firing of a rocket and occurrence of explosion. Range of "Standard MM100" is 100 milliseconds. Other ranges available for longer or shorter intervals.—*Rowe Radio Research Laboratory Co., 2422 North Pulaski Rd., Chicago 39, Ill.*

Hour-scale Elapsed-time Meter

New "Aero Running Time Meter" registers total operating (or idle) time of any machine or circuit to which it is connected, operates on 120-volt (±20%) 50- or 60-cycle (as specified) a-c. supply, consumes 2 watts. Range is 9999.9 hours and instrument resets automatically at 10,000 hours. "Model 1001" (illustrated) is 3½" flange-diameter and 2¾" body diameter, 2⅜" deep from flange to back (recessed terminals at back). Slow-speed self-starting synchronous motor requires no lubrication service. One-year guarantee is given and prices are said to be attractive.—*Sales Engineering Associates, Inc., 3907 San Fernando Road, Glendale 4, Calif.*

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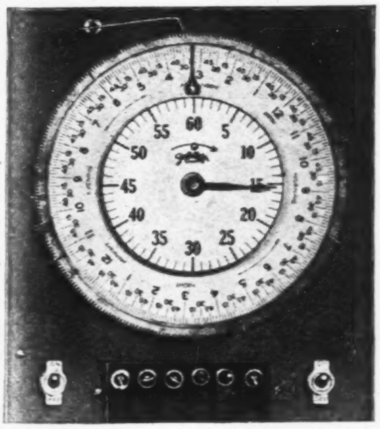
TOTAL 00000 HOURS
120 VOLTS 60 CYCLES
MODEL 1001

Program Timer

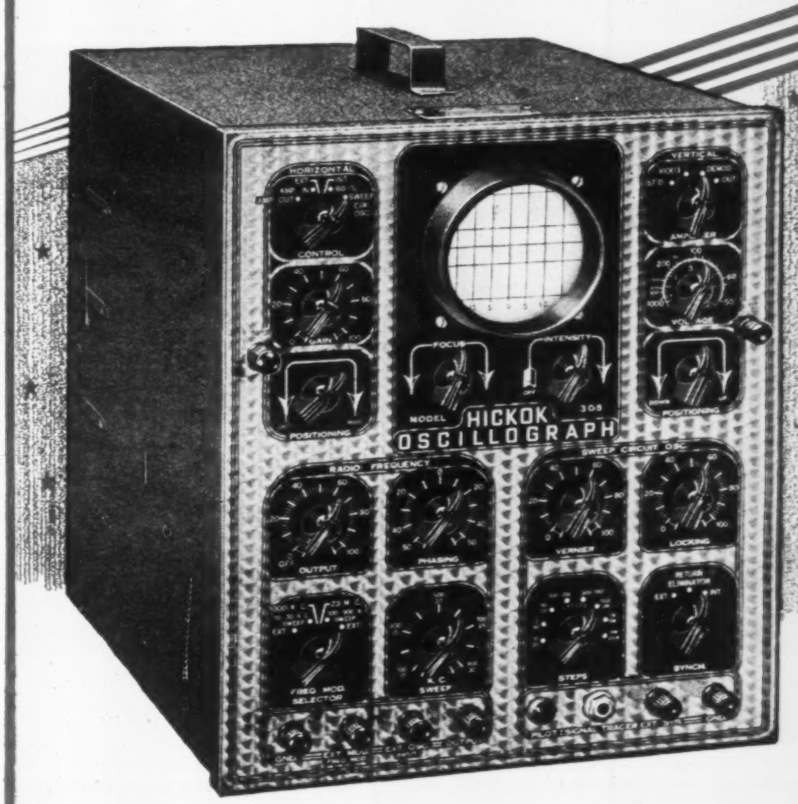
New Program Timer is synchronous-motored for greatest possible accuracy of signals at any 5-minute period in a 24-hour schedule, with circuit closure from 5 to 60 seconds precisely at time specified. It is designed for uses in factories, airports, railroads, schools, hotels, etc. As many as 288 operations a day are possible. Program mechanism is set automatically by turning minute hands as on an ordinary clock. Schedule is easily changed any time without use of tools. Small spring brass clips are inserted in slots of program disk for desired program. These pins select the operating times. Operation is performed by a



In Your Behalf

A dependable OSCILLOGRAPH

R. F. O.–5


HORIZONTAL
CONTROL
POSITIONING
FOCUS
INTENSITY
MODEL 305
HICKOK OSCILLOGRAPH
VERTICAL
AMPLIFIER
VOLTAGE
POSITIONING
RADIO FREQUENCY
OUTPUT
PHASING
SWEEP CIRCUIT OSC.
VERNIER
LOCKING
FREQ. MOD. SELECTOR
SWEEP
STEPS
RETURN ELIMINATION
SYNCH.

The HICKOK OSCILLOGRAPH R.F.O.-5 is especially designed for frequency modulated, amplitude modulated, and television service. This is your instrument for COMPLETE VISUAL ANALYSIS.

Self-contained Wide Band and Narrow Band F. M. Oscillator, Demodulator, Video Amplifier, Signal Tracer, Visual A.C. Vacuum Tube Voltmeter. It features high sensitivity amplifiers, returns trace eliminator, calibrated screen, variable width frequency modulated oscillator, pilot light and phasing control.

Power supply, 110 to 120 volts, 50-60 cycles. Size, 11"x13"x15¼". Finished in baked crackle lacquer. Shipping weight, 55 lbs. Shipped on WPB authorization 3243. Otherwise, orders must be accepted for shipment after WPB restrictions are removed. Advise whether you wish New METER Catalog or New RADIO SERVICE EQUIPMENT Catalog.

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10519 DUPONT AVENUE CLEVELAND 8, OHIO

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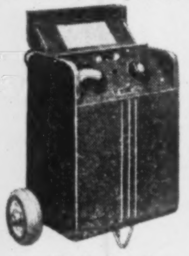
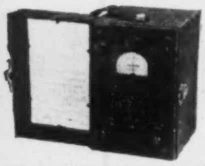


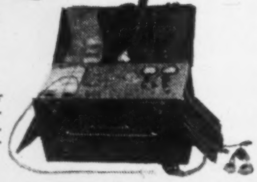
HYPOT—High voltage Insulation Breakdown Tester. Rubber Tired Wheels.

HAND TACHOMETER Measures r.p.m. and feet per minute.

VOLTAMMETER 8 ampere ranges 3 voltage ranges



VIBROGROUND Measures ground resistance.



Model 302 Keeler Polygraph (Lie Detector) shown to left. Complete in one instrument.

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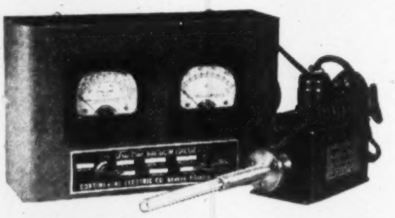
set of cam-operated contacts. Silver contacts operate with snap action. Rating 10 amps. at 110 volts. Steel case is 8" × 12" × 4".—*Zenith Electric Co., 152 W. Walton St., Chicago 10, Illinois.*

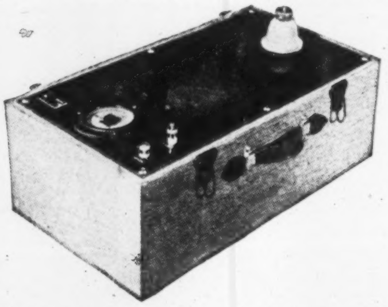
Direct-reading Vacuum Gage

New improved model of "Tru-Vac" vacuum gage is of the Pirani type as was previous model. In addition to accuracy, announcement emphasizes availability for use in "high-vacuum processes of all kinds." Previous model is said to be "proving itself valuable to manufacturers in more than 50 types of industries." New model is said to give instantaneous and continuous reading within a range of 0 to 3000 microns. It is adaptable to any high-vacuum pump or system; is easily placed on any desirable point on the vacuum system. New gage is d-c.-operated, requires only one or two No. 2 dry cells and may be installed in rubber, sealed to hard-glass or soft-glass systems, or coupled to ½" standard pipe connections. —*Continental Electric Co., Geneva, Illinois.*



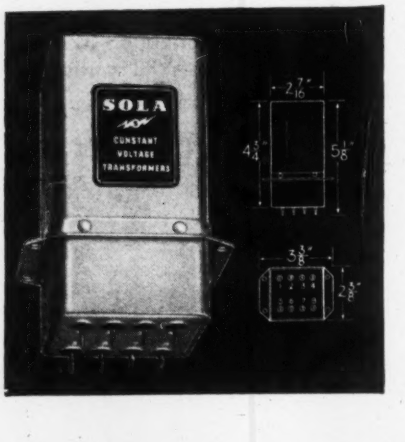
Portable Kilovoltmeter

New "Type 772" portable 2-scale d-c. kilovoltmeter has scale ranges of 0-2 kv. and 0-20 kv. Unit is assembled in oak case with carrying handle, making it suited for a wide variety of uses. — *Shallcross Mfg. Co., Jackson & Pusey Avenues, Collingdale, Penna.*



"Through-chassis" Form of Voltage Regulator

New small hermetically-sealed constant-voltage transformer for through-chassis mounting has been designed for such applications as heating and refrigeration controls, television and FM receivers, vacuum-tube voltmeters, electronic gaging and inspection equipment, photometric instruments, etc., where precisely-regulated supply voltage is mandatory. At any reasonable transformation ratio of input to output it will provide a single output voltage constant to within ±1% of rated requirements regardless of line voltage variations to ±15%. Capacities up to 15 va. 60-cycle operation are available and are supplied with a separate capacitor unit for external mounting. — *Sola Electric Company, 2525 Clybourn Ave., Chicago 14, Illinois.*

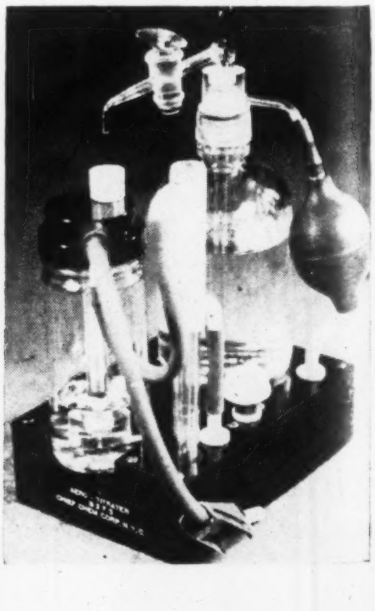


Temperature Switch

New "Type T-2 Ther-MU-trol" embodies maker's standard "Type M MU-switch" in a thermostatic control capable of handling loads up to the full 15-ampere 125-volt a-c. rating of this switch, is applicable to remote control of temperature in liquids, gases, and solids, through a calibrated, continuously-adjustable range of 200 to 600°F. A built-in safety device enables new unit to withstand temperatures up to 50° beyond maximum calibrated range. Temperature-measuring system of "Type T-2 Ther-MU-trol" is of the hermetically-sealed liquid-filled type consisting of bulb, bellows, and capillary tube. Control housing which contains "MU-switch" and calibrated dial is of brass: 3" diam. by 2-15/16" deep and mounts by two 10-32 screws on 2-7/16" centers. New "Type T-2 Ther-MU-trol" is applicable to control of electric heating elements for embossing presses, hot-plates, heat-treating salt baths, deep-fat fryers, etc. —*MU-Switch Corp., 38 Pequit St., Canton, Mass.*

Rapid Water Analysis Apparatus

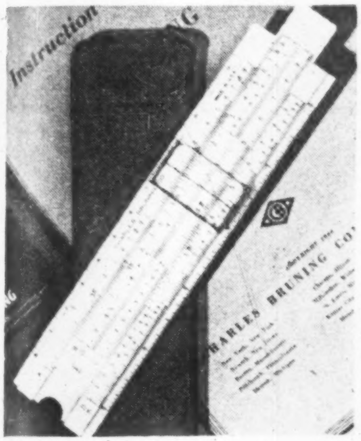
New "Aero-Titrater" is said to furnish plant operator and laboratory technician with a rapid, precise method for determination of hardness, calcium and magnesium in industrial and potable waters; is widely applicable also to water problems in process industries. False endpoints are said to be absent. Air agitation obviates need of tedious shaking by hand. Accuracy is said to be comparable with that of gravimetric methods and it is said that substances ordinarily present in water do not interfere at all. It is said that any operator can readily master operation of apparatus, which makes use of a new endpoint based on foam-meter principle. This endpoint is unmistak-



able and is reproducible with a high degree of precision. Determinations are made within ten minutes and there is no waiting time to observe stability of lather. Operation is foolproof and gives identical results with different operators. Instrument is supplied calibrated and ready for assembly and use. There are no moving parts. All vital parts are of durable plastic construction. "Aero-Titrater" is said to be readily usable with waters which resist analysis by traditional soap methods. Ratio of calcium and magnesium present does not affect determination; there is a single endpoint for stoichiometrically equivalent quantities of calcium and magnesium, regardless of relative amounts present in the water. Samples of 50 ml. or less are required (in contrast with gravimetric methods involving evaporation of one-half liter or more and subsequent precipitation waiting periods). Instrument can be used directly with samples which contain chlorides up to 2000 ppm. Sulfates up to 1000 ppm are also without effect. Large iron concentrations, and the treating and conditioning chemicals and compounds used in boiler waters do not interfere. Micro determination of Ca and Mg in boiler scales, minerals, plant ash, rocks, sediments, and similar materials is made with ease—in many cases in the presence of practically all the impurities in the samples.—*Chief Chemical Corp., 1123 Broadway, New York 10, N. Y.*

Pocket Slide Rule

New "Bruning 2401" is a 5" pocket slide rule described as "a high-precision, high-quality pocket slide rule which could be offered to engineers at a moderate price."



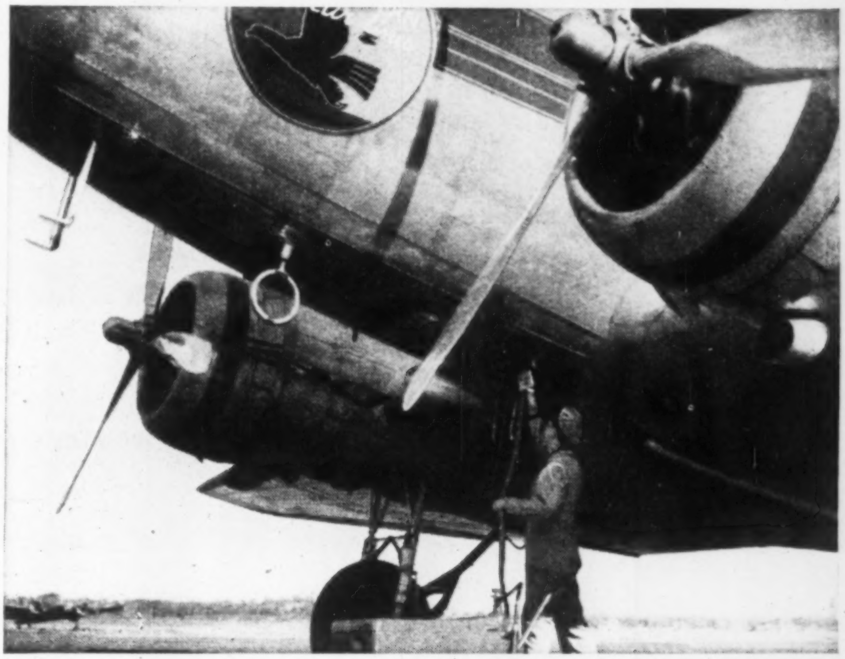
Feature is said to be precision of graduation which, being molded in, will not lose visibility through use. Graduations and numerals of the CI scale are in red to facilitate reading. Three screws in back of rule provide a simple adjustment for tension on slide. Indicator (of glass: easily replaceable in event of breakage) is enclosed in stainless steel frame that eliminates "wobble." A, B, CI, C, D, K, S, L and T scales make new rule adaptable to wide range of service. Beveled edges are graduated in inches and centimeters.—*Charles Bruning Co., 4700 W. Montrose St., Chicago 41, Ill.*

Geneva-movement Type Electric Servos for Positioning

New "Geneva-loc" positioning actuators are the first units of an entirely new line of electric actuators, are said to offer extremely accurate control within 1° of any series of operations up to eight positions with each position positively locked against movement. As name implies, these new actuators incorporate a Geneva movement operated by a high-speed motor. Positioning by limit switches has been eliminated. It is said that five advantages result: (1) positive control of output shaft movement which automatically locks at all stops and which is independent of motor over-travel and

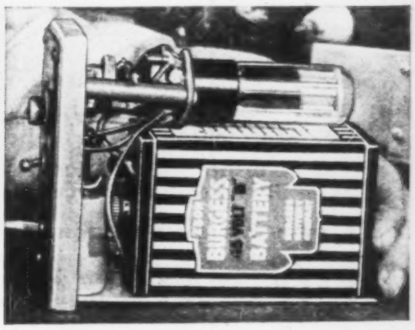
PORTABLE POWER PROBLEMS

THIS MONTH—EASTERN AIR LINES' RADIO COMPASS TEST UNIT



ACCURATE PRE-FLIGHT tests of vital automatic radio compasses on all planes operated by Eastern Air Lines are quickly made with a portable, *battery-operated* oscillator unit. The time-saving, dependable instrument was developed by Eastern radio engineers, who selected Burgess Batteries to provide the necessary voltage for test readings.

WARNING
REMOVE LINK AFTER TEST
OFF
ADF TEST OSC.
AIRCRAFT RADIO
#101



THE OSCILLATOR UNIT is not influenced by external conditions, permitting service technicians to check for dangerous radio compass defects while aircraft are inside hangers or close to metal objects, long before plane departure time. Burgess Industrial Batteries are designed to meet the requirements of exacting special applications. Let Burgess engineers help you solve *your* portable power problems. Write us today about your specific needs, or *send coupon for free Engineering Manual. Burgess Battery Company, Freeport, Illinois.*

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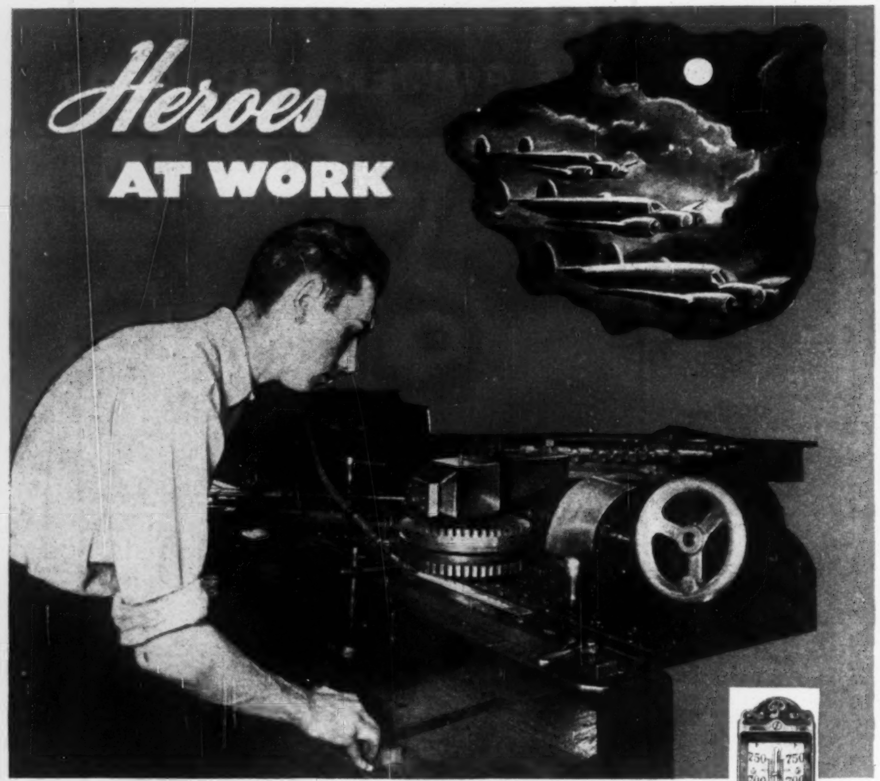

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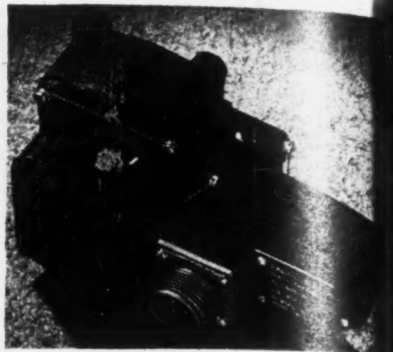


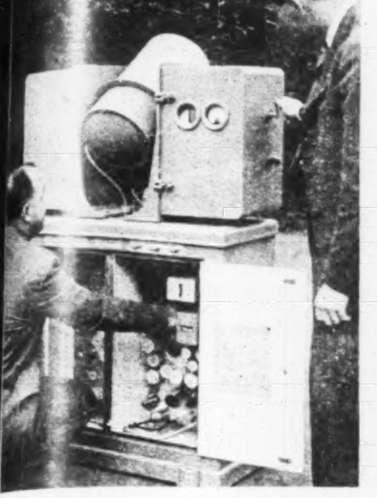
temperature variations; (2) no clutch torque limitators, brakes or adjustable li switches; (3) motor comes up to sp under no load, then engages cam with va ing ratio which develops maximum torq at breakaway positions, thus cutout switch always operate when motor is under load, permitting maximum switch life; (design permits two-to-eight positions; (entire unit can be disassembled and rea sembled, or interchanged quickly in the fie New "Geneva-loc" actuators are said to ideal for remote operation of hydrau valves, two-speed supercharger contro fuel selector valves (detents not necessary spark retard, prop feathering, air du valves or any similar installation where a curate positioning is desired.—*Pacific Di Bendix Aviation Corp., 11600 Sherman Wa North Hollywood, Calif.*

Mercury-arc Ultraviolet Sources

New line of standard and special "Blac Light Lamps" of mercury-arc type is an nounced. Illustration shows bench ty "Black Light" in use. "Black Light Ray master" is available in both standard mod els and custom-engineered units.—*Geo. W Gates & Co., Hempstead Turnpike & Lucill Ave., Franklin Square, N. Y.*

Daylight Cloud-ceiling Recorder

New "Novalux Ceilometer" pulsating light system with photoelectric detecto makes it possible, for first time in aviatio history, to measure in daylight cloud ceil ings as high as two miles. Developed by L. W. Foskett of U. S. Weather Bureau in conjunction with G.E. Lighting Div. en gineers, system consists of a mercury ar projector, a pick-up unit known as a ceil ometer, and a recorder which provides a continuous record of ceiling height and rela tive cloud density. A tiny "super-high-in tensity" quartz mercury lamp is mounte at the focus of a searchlight mirror to pro ject a 120-c.p.s. pulsating beam vertically Not visible to human eye in daylight beam is scanned readily by ceilometer unit (illus trated) which consists of a phototube pick-



p and amplifier feeding to an output meter, s located 1000 feet from the projector and s tuned to same frequency as light pulse in rder to distinguish mercury-light signal rom background light. Scatter energy, produced on cloud layers dense enough to scatter the beam, is detected as the ceilometer cans the beam. A Selsyn drive, between he ceilometer and the recorder, translates osition of the ceilometer into cloud heights n the recorder. Operating at an extremely igh temperature, tiny quartz lamp must e cooled. G-E engineers developed a high-ressure air jet cooling mechanism consisting of a motor-driven compressor enclosed n weather-proof housing. Entire device perates from a 60-cycle 110-volt a-c. line. —*General Electric Co., Schenectady, N. Y.*

Porosity Tester

Originally designed for determining porosities of various types of sponge rubber, new Hahn-Judson Porosity Tester is suitable for testing upholstering materials and other materials of relatively large bulk and test-area. Fig. 1 shows its operating principle. It is essentially a nine-inch tube with a six-inch square hole in the base. Air is drawn through square opening on bottom by the centrifugal blower and exhausted through the hole at the left. When instrument is placed on a sample, air pressure in the volume above the sample is reduced. The static pressure of this space is measured by the diaphragm type draft gage mounted on right side of case. A spring on draft gage forces the indicating hand to move to the right. As a less porous sample is placed under the instrument, the static pressure being measured becomes less, forcing the

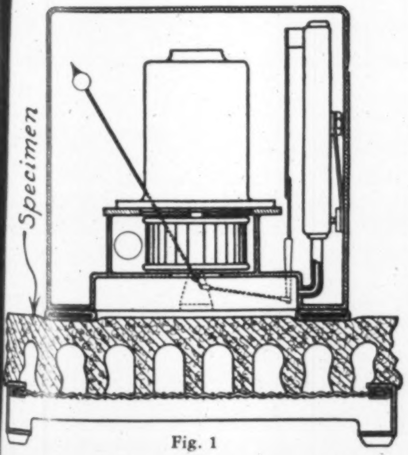


Fig. 1

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Microphones
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Phonograph Cutting Heads
Phonograph Pick-ups
Vibration Pick-ups
Polarized Relays
Generators
Meters
Magnetron Fields

AUTOMOTIVE AND AVIATION EQUIPMENT?

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Tachometers
Compasses
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Motors
Speedometers
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Oscillographs
Flux Meters
Watt-hour Meters
Flow Meters
Light Meters
Cardiograph Recorders
Vibration Pick-ups

MISCELLANEOUS PRODUCTS?

Magnetic Separators
Magnetic Chucks
Magnetic Conveyors
Magnetic Clutches
Magnetic Damping Devices
Arc Blow-out Magnets
Temperature and Pressure Control Equipment
Circuit Breakers
Limit Switches
Holding Magnets
Clocks
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Coin Separators for Vending Equipment

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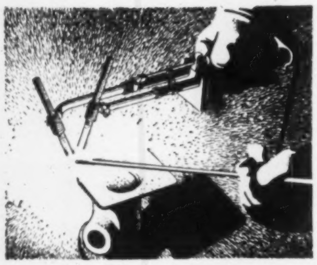
New 9000° Arc Torch Can Be Used for Welding and Brazing All Ferrous and Non-Ferrous Metals and Alloys

Now an arc torch that makes it possible to do most jobs *electrically* that previously were thought possible only with gas. This attachment for arc welders provides an independent source of heat by means of two carbons. It is capable of producing intense heat, approximately 9000° F., over 2000° hotter than an oxyacetylene flame. Pure heat, no oxygen or gas to contaminate the weld. No pressure to force the molten metal away or blow holes in light sections.

Developed to capitalize to the fullest on the time-saving advantages of electric welding, the new Mid-States 9000° arc torch can be used with any AC or DC electric welder. It opens up new horizons of service in this field, never before possible with an electrically operated instrument.

New uses are being found every day for products that have been familiar to us for years. Wrigley's Spearmint Gum, always enjoyed for its chewing satisfaction, is now proving with the fighting men overseas many benefits which will be useful to you in peacetime. One of the big factors in mass production is the alertness and efficiency of the man on the job. The chewing of Wrigley's Spearmint will help keep you alert and wide-awake during those work periods that, while seemingly dull and monotonous, call for watchfulness in order to get perfection in the final assembly.

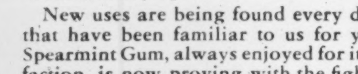
*You can get complete **information** from Mid-States Equipment Co., 2429 S. Michigan Ave., Chicago 16, Illinois.*



For BRAZING Steel, Cast Iron, Malleable Iron, Copper, Brass, Bronze, and other ferrous and non-ferrous metals.

For HEATING to Straighten or Bend, etc.

Y-168



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With a MODEL J
HAND TACHOMETER

Triple Range: 300— 1200 RPM
1000— 4000 RPM
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HERMAN H. Sticht COMPANY, INC.
27 PARK PLACE NEW YORK, N. Y.

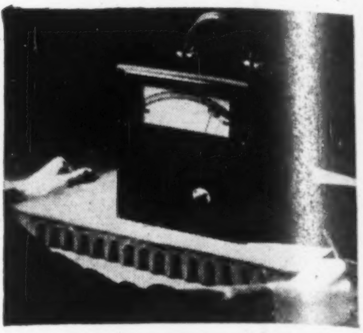


Fig. 2

indicating hand to the left. All test pieces should be placed on top of the small platform, providing ample clearance for air to pass through. Sample should be larger than base of instrument so that air will pass through the sample more easily than around the edges of the instrument. New porosity tester weighs 18 lbs.—*B. F. Goodrich Co., Akron, Ohio.*

Linear Ohmmeter

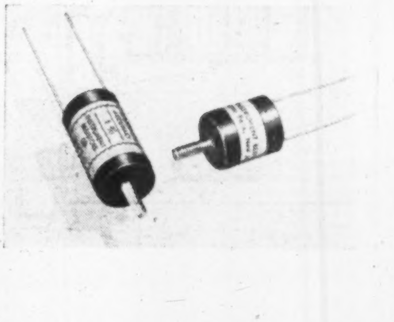
New "Type LM21 Linear Ohmmeter" was designed for production use wherein measurements within a restricted range of electrical resistance are required. It has a linear

LINEAR OHMMETER

scale calibrated directly in ohms which fits it for use by inexperienced operators. It is said to be so engineered that length of leads to resistance under test has negligible effect on accuracy. Units are available for practically any full-scale value of resistance including fractions of an ohm. Standard units are battery-operated but can be had with a power supply if required. Instrument is in a black wrinkle baked enamel finished case approx. 11" long by 8" high and 8" deep. — *Rowe Radio Research Laboratory Co., 2422 North Pulaski Rd., Chicago 39, Ill.*

Tropicalized Resistors

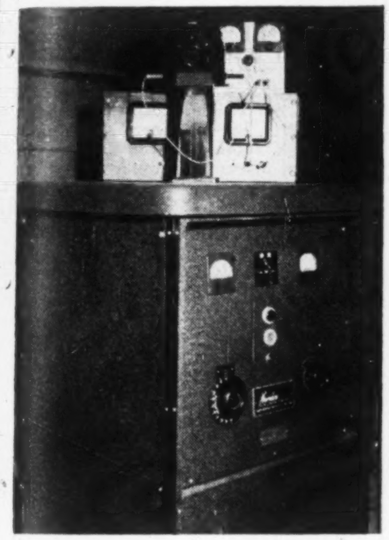
New line of "Tropi-Pruf" resistors protected against deterioration and resultant failure in tropical or humid locations is said to be complete. Each component is enclosed in a Bakelite case. After dehydration the resistor is sealed in "a special compound" and further made impervious to atmospheric surroundings with Bakelite cap machined to fit the Bakelite case. At point of entrance through case, bare leads are hermetically sealed so that no creepage of moisture or fungus growth can take place at any point. After completion of unit, a fungicidal coating is applied. This coating

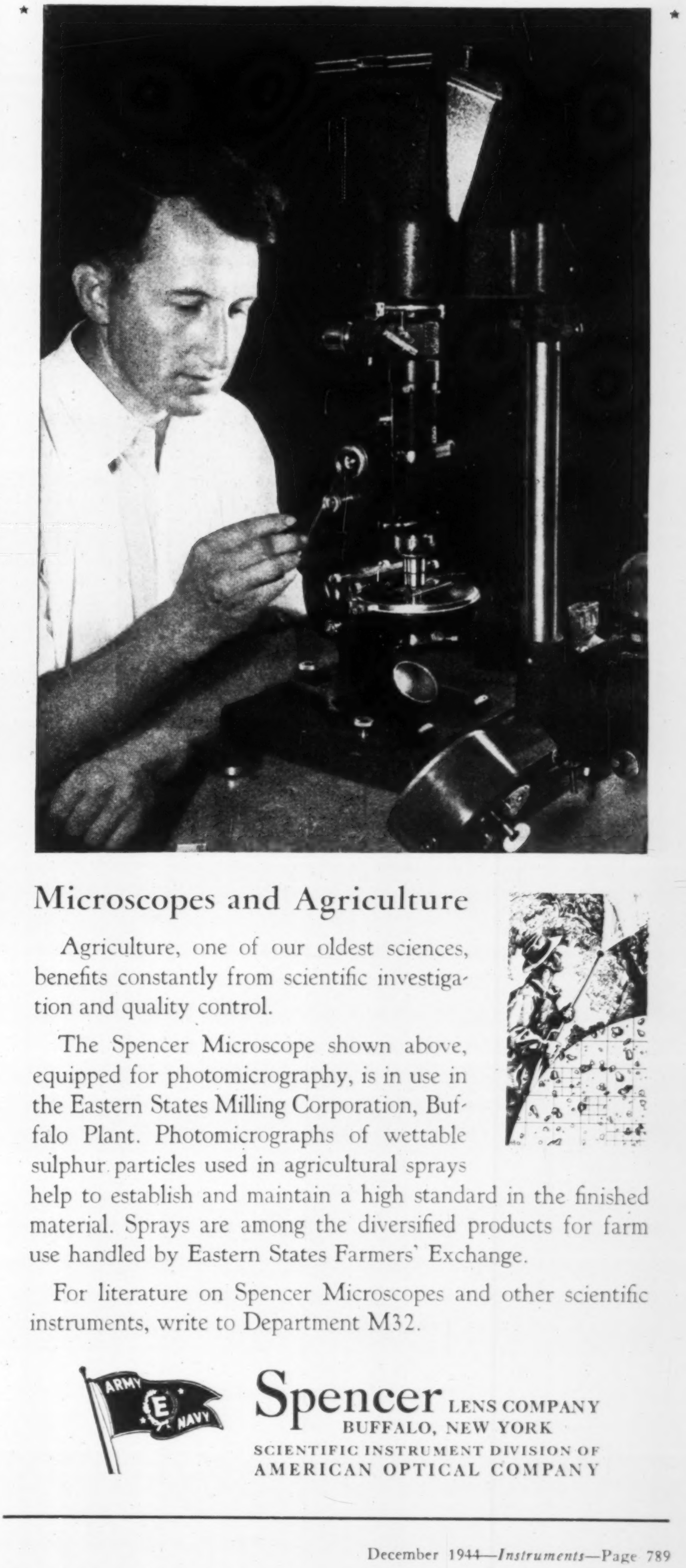


is non-toxic, meets all Signal Corps No. 71-2202-A specifications and is effective for about one year. New units are available in a diversity of resistance values and wattage ratings. Accuracy tolerances suitable for either general or precision applications are available.—*Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.*

X-ray Irradiation Unit

New x-ray irradiation unit for precisely adjusting the frequency of quartz oscillator plates downward has been fully developed. It employs a new high-capacity water-cooled tube that attains the highest possible efficiency. Because apparatus utilizes an extremely intense beam of x-rays, problem of protecting operator from stray radiation was critical. It was solved in Philips design by using a rotary fixture that exposes one crystal to the beam while another crystal is being loaded into a second holder. First holder (in front of x-ray window) is connected, by means of its electrodes and a system of contacts, to a pair of insulated external leads; these may be connected to an oscillator. In this manner, downward drift of frequency can be accurately measured and the crystal removed from the beam when the necessary change has been accomplished. Crystal connection arrangement is said to contribute much to speed and convenience in production work. Front electrode is open, exposing a definite percentage of crystal area to the x-ray beam. (The most efficient area to use was determined through experimentation.) Depending on original characteristics of plate, frequency may be lowered in the x-ray unit at a rate of 30 to 50 cycles per second per minute. It is possible to change the frequency of plates in the 6-8-Mc. range from 2-3-kv. per second total—this is the saturation value of such crystals. Higher-frequency plates can be changed over a larger range. Crystal holder is arranged so all crystal sizes from 0.4″ × 0.4″ up to 0.75″ × 0.75″ can be accommodated. Two crystals of each size may be placed in each holder: one treated while the other is being loaded. Makers developed this equipment at request of U. S. Army Signal Corps. Dr. Clifford Frondel of Reeves Sound Laboratories has experimented with this method which requires no artifical loading of the oscillator plate with foreign material, makes close control possible and produces a change in frequency which is permanent throughout and beyond any temperature range that the crystal is likely to experience. Actual factory applications of the technique includes: (1) Recovery of overshot crystals carried too far in finishing; (2) precise adjustment of standard crystals; (3) manufacture of precision crystals for frequency and time standards: a crystal which is considered stable can be precisely adjusted to final frequency without possibility of age-drift;





Microscopes and Agriculture

Agriculture, one of our oldest sciences, benefits constantly from scientific investigation and quality control.

The Spencer Microscope shown above, equipped for photomicrography, is in use in the Eastern States Milling Corporation, Buffalo Plant. Photomicrographs of wettable sulphur particles used in agricultural sprays help to establish and maintain a high standard in the finished material. Sprays are among the diversified products for farm use handled by Eastern States Farmers' Exchange.

For literature on Spencer Microscopes and other scientific instruments, write to Department M32.

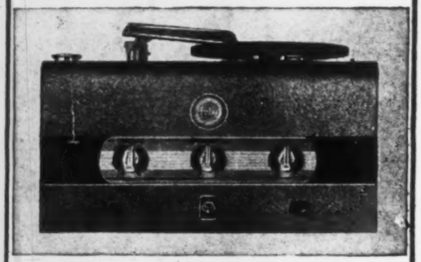
ARMY E NAVY

Spencer LENS COMPANY
BUFFALO, NEW YORK
SCIENTIFIC INSTRUMENT DIVISION OF
AMERICAN OPTICAL COMPANY

AGASTAT
TYPE NO-21 NO. 60001
TIMING MIN. .5 SEC.
COIL MGM-24 V. DC CY.
PATENTED
ELIZABETH A'G'A NEW JERSEY
AMERICAN GAS ACCUMULATOR CO.
AGASTAT
ELECTRO-PNEUMATIC RELAY

COMPACT:
4 IN HIGH
2½ IN DEEP
2½ IN WIDE
WEIGHT:
1½ POUNDS

ELIZABETH A'G'A NEW JERSEY
AMERICAN GAS ACCUMULATOR COMPANY


20-WATT UNIVERSAL
AMPLIFIER

Plug in for A.C. or 6-volt auto battery; no power pack necessary. Uses mike and built-in phono at same time. 78 RPM motor, 9-inch turntable, crystal pick-up, separate on-off switch. Long-playing needle included. Continuously variable tone control on inclined eye-level control panel. Use one or two 8-ohm speakers without need of extra transformer. Has one 6SJ7GT, one 6SC7, two 6L6Gs in push-pull, two 6X5GTs. Model 6720, with tubes, F.O.B. New York $56.28 Model 6721, same as 6720, less phono player $42.87

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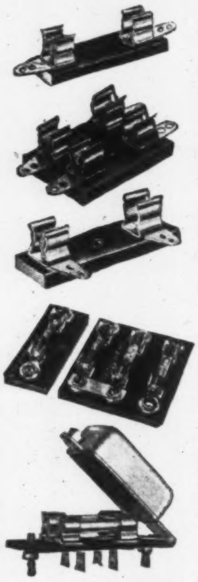
Littelfuse
FUSE MOUNTINGS
for 3 AG FUSES
(Fuse size: 1¼" x ¼" dia.)
Single, double and multiple pole mountings.

Open Type Single Pole Mounting No. 351001 (Old No. 1060). Black bakelite base. Overall length, 2⅛". Shakeproof terminals. One mounting hole.

Open Type Double Pole Mounting No. 351006 (old No. 1068) Same as above but double pole.

Light weight Single Pole Mounting No. 351003 (old No 1128) 1⅓" x 9/16" x 9/16". Bakelite mounting strip, fibre insulator bottom for metal panel mounting. One mounting hole.

Universal Fuse Panel No. 1505 Series. Standardized units for 10 fuse sizes, any practicable number of poles. Send for blueprints.

Covered Type Double Pole Mountings. Double Pole No. 351009 (old No. 1237-B). Underwriters' Approved. Fibre-lined, metal-shielded cover hinged to bakelite base.

Littelfuse Mountings made for all fuse sizes. Ask for details.

LF LITTELFUSE INCORPORATED
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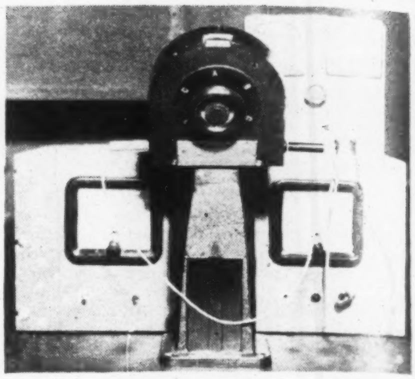
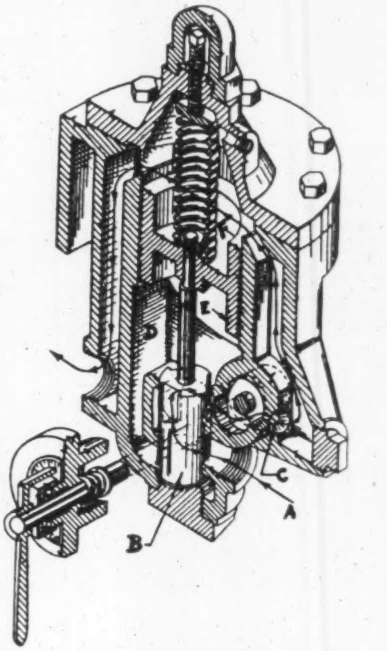
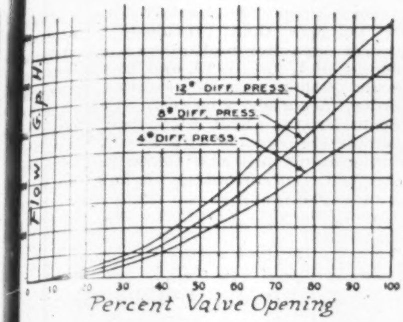


(4) adjustment of frequency of a standard crystal at a given temperature. New unit utilizes highly efficient energizing equipment with a rated output of 60 kv. at 25 ma. It is a full-wave assembly, utilizing two rectifier tubes. The water-cooled x-ray tube insures continuous operation at peak electrical output. Controls are conveniently located.—*North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y.*

Oil Valve for Automatic-control Applications

New "Bloom Constant Oil Flow Valve" permits large changes in valve opening with small changes in flow at minimum settings, also equal percentage increase in flow for settings up to approx. 50%. It is essentially a piston-operated differential pressure valve in combination with an orifice valve (Fig. 1). Mechanically, it consists of a body, piston, valve stem B and integral orifice valve C. Piston is rigidly attached to valve stem and resets itself according to pressure changes or changes in volume demand as called for by orifice valve settings. Differential maintained is usually 10 lbs./in.^{2}. Satisfactory operation is obtained with differentials as low as 4 lbs./in.^{2}. Fig. 2 shows flow curves at 4, 8 and 12-lb. settings. Because a constant differential pressure is held, a set rate of flow is delivered regardless of upstream or downstream pressure variations. In Fig. 1, arrows show path of oil flow. Valve is designed for oil flow through all parts of the valve at all times, to prevent carbon deposits. In operation, piston is held in balance by oil pressure in chamber D, opposing spring pressure plus oil pressure in chamber F. Pres-





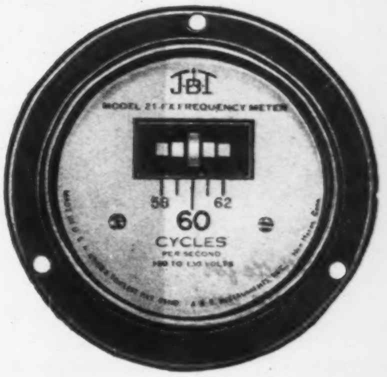
ure variation in either chambers causes iston movement until balance is restored. f downstream pressure increases, pressure ncreases at F, causing downward piston novement opening V-ports in stem B until alance is restored. A decrease in downstream pressure causes the reverse to take lace. On the other hand, if *upstream* pressure increases, piston is unbalanced upward, losing V-port in stem B until balance is estored. A decrease in upstream pressure auses the opposite to take place. New valve as been used to control flow on liquid-fuelred furnaces. It is said to be particularly dvantageous on an open-hearth or reversng furnace where unbalance in burner ressure causes different flows on the two nds of the furnace. A mounting plate is rovided for temperature control motors. Then combustion ratio control is used, here is mounted on the valve a pilot loader hich, by means of a square-root cam, evelops an air pressure loading in proporon to oil flow. This pilot air can then be sed to balance a diaphragm-type ratio regator.—*Bloom Engineering Co., 857 W. orth Ave., Pittsburgh 12, Penna.*

Electrostatic Voltmeters

New "Type 518" electrostatic voltmeters re said to offer many features not preiously available in commercial instruments. hey are intended for the measurement of igh voltages and draw extremely low curent from the source. They will measure

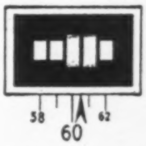
ither d.c. or a.c. accurately, giving exact .m.s. readings on a.c. Frequency response s said to be good, without appreciable erors even at low radio frequencies. For d.c. easurements there is no appreciable curent drain, because of new insulating marials used. Insulation resistance is guarnteed to be higher than one million megohms. This makes it possible to measure igh-voltage sources designed for a load, urrent of only a few microamperes without disturbing circuit. It is possible to use ew voltmeters for measurement of voltages f electrostatic nature, such as are generated n manufacturing paper, cloth, celluloid, tc. Measurements are made by the use of ollector plates or brushes and are possible ecause this type of voltmeter does not ischarge the source. For a-c. measureents, input impedance is that of a small apacitance in parallel with a very high eakage resistance. (Example, the 5000-volt nstrument has a capacitance of around 8 icromicrofarads and a resistance of sevral million megohms. At low frequencies his is practically an open circuit with no urrent drain.) Instruments are said to be ompletely free from waveform and fre-

How to Read a
VIBRATING REED FREQUENCY METER
in
1
Easy Lesson!

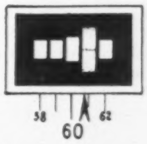


for example:

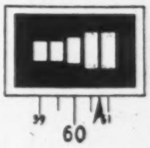
ON THE NOSE! Model 21-FX, smallest frequency meter ever manufactured, shown indicating a frequency of 60 cycles. The 60 cycle reed is vibrating to full amplitude, with the adjacent 59 and 61 cycle reeds practically at a standstill.



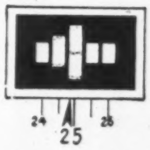
60.5 cycles. The 60 and 61 cycle reeds are vibrating *equally*, but to less than full amplitude. Side reeds are quiet.



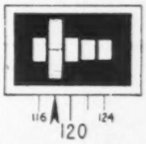
60.75 cycles. The 60 cycle reed is vibrating a little, and the 61 cycle reed is vibrating to almost full amplitude. Other reeds are quiet.



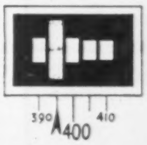
60.75 cycles. Note this is a half-cycle instrument. The 60.5 and the 61 cycle reeds are vibrating equally.



24.85. Watch the scale! Each division is one half cycle. Frequency lies between 24.5 cycles and 25 cycles and closer to 25 than 24.5.



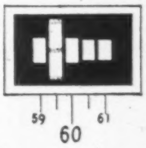
118.0. This one is easy. Each division represents *two* cycles. The 118 cycle reed has no competition in this example.



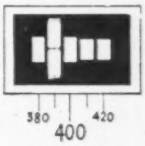
395. This is a cinch, too. How many cycles per division? Five—right. The 395 cycle reed has everything its own way, here.

Now, how good are you? **Watch your Scales!**

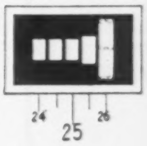
A



B



C



SIMPLY READ THE REED
That's Your Frequency!

Bulletin VF-43 with supplements gives detailed descriptions of the complete line of J-B-T Frequency Meters. Your copy is waiting for you.

J-B-T

Answers, but
NO PEEKING
A = 59.5
B = 390.0
C = 24.0

(Manufactured under Triplett Patents and/or Patents Pending)

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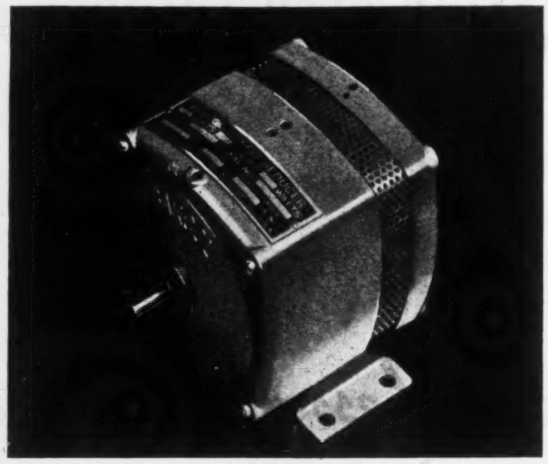

Write for Data and Prices

ENCLOSED GEARED-HEAD MOTORS

350 r.p.m. to 1 revolution in 7 hours

Since their introduction 6 years ago, these motors have proved extremely satisfactory in service and have been applied successfully to such exacting jobs as driving telescopes, radio beam directors, voltage controllers, and similar applications. Practically any gear ratio from 7.2/1 up to 1,098,632/1 can be furnished. Available with either shaded-pole induction or synchronous motor. Shaft is centrally located. Accurate, durable construction throughout.

BARBER-COLMAN COMPANY
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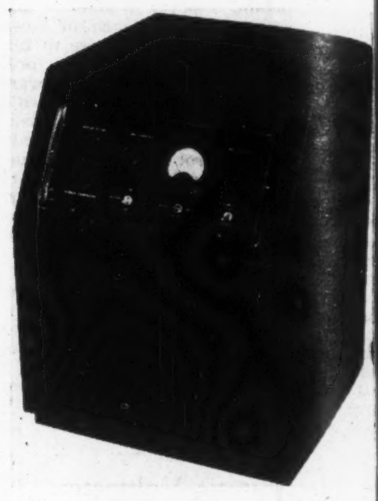
quency errors; are available for uch hig er voltages than previously w hout t use of capacitor multipliers; ar offered ranges of 1, 2, 3, 5, 10, and 20 ki volts fu scale. Other ranges available n speci order. Accuracy guarantee, 1% r bette Scale length, about 5½". Instru nents a completely portable with walnut ses. Mo ing systems are said to be rug edly co structed and adequately damped to faci tate rapid readings. — *Rawson Electric Instrument Co., 112 Potter St., ambrid 42, Mass.*

Voltage Regulator

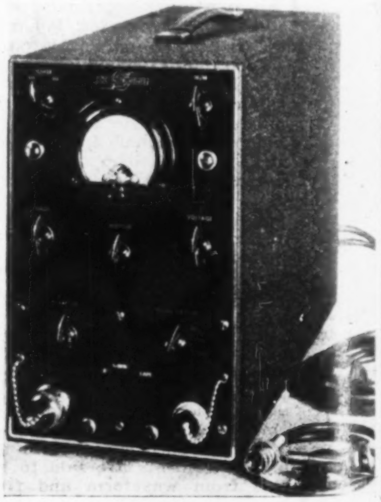
New "Electronic Voltage Reg ator" said to be admirably suited for onverti the fluctuating voltage obtained rom com mercial 115-volt 60-cycle a-c. circuits to



highly stabilized voltage to operate pr cision photoelectric densitometers and sim lar equipment. Output power is 160 wat at 110 volts, a.c. Output voltage may adjusted from 100 to 120 volts. Regulati factor is about 1000, thus reducing a 1 volt input fluctuation to a few tenths of volt. It is claimed that frequency change input voltage will not vary output voltag Complete stability is obtained in seve minutes after starting the unit. Regulat is 26" high, 19" wide and 22" in dept weighs 100 lbs.—*Harry W. Dietert Co 9330 Roselawn Ave., Detroit 4, Mich.*

General-purpose Amplifier

New "Cox Type 2 Portable Amplifier" a general-purpose self-contained 3-stage re sistance-capacitance-coupled amplifier wi a flat frequency range of 1 to 15,000 cp (usable to 100,000 cps.). Announcemen



AMINCO *LoLag*

ELECTRIC HEATERS and Controls

WHETHER for heating fluids, semi-fluids, solids, air or other gases, there is an Aminco Electric Heating Unit and reliable, time-tested automatic controls that will do the job dependably and efficiently. Aminco heating specialists can design and build special units for almost any heating requirement.

Left: Flexible immersion type of Aminco Electric Heater, available in lengths up to 13 ft., which can be bent easily to fit any vessel and nested to provide various combinations of heater wattages.

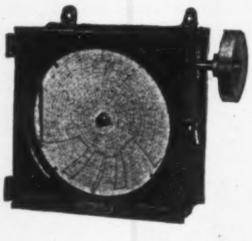
Below: Pipe-thread type for screwing into various types of vessels. Single and 3-heat types, with or without built-in switches.

Strip, cartridge, open coil, and room-heating types are also available.

Write for Bulletin D-2075

AMERICAN INSTRUMENT CO.
Silver Spring, Maryland

Amthor



Operation Speed Recorder 8" Chart 12 or 24 hr.

Built for severe service. Users report 10, 12 or more years of trouble-free life. Powerful centrifugal speed-measuring element stays calibrated. Non-spill reservoir pen. Special chart paper. Rugged clock movement. Ideal for analysis of new War Effort jobs.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems. Drop us a line today.

Amthor Testing Instrument Co., Inc.
49a Van Sinderen Ave. Brooklyn, N. Y.

states that this unusually low frequency response enables it to serve in many applications for which a direct-coupled amplifier would be normally used without the objectionable direct-coupled amplifier instability. New amplifier was designed as a part of maker's equipment for study of pressures and vibrations and for strain gage applications. It is said to be ideally suited to the study of infrequent and non-recurring phenomena. Its input range of 0.1 to 1000 millivolts and gain of 80,000 (98 db) are said to be sufficient for all normal applications where preamplification is required. Maximum harmonic distortion, 3%. Power supply 50-60 cps; consumption, 60 watts. Dimensions, 1[illegible]¾" × 7½" wide × 17¾" deep; weight [illegible] lbs.—*Commercial Research Laboratories, Inc., 20 Bartlett Avenue, Detroit [illegible], Mich.*

Knoop-NBS-method Hardness Tester

New "Tukon Tester" is highly-refined embodiment of diamond pyramid indenter method invented (USP 2,091,995) by Frederick Knoop of National Bureau of Standards and described in *NBS Research Paper 1220*: Indenter is of diamond and produces a "diamond" shape indentation with approx. 7-to-1 ratio of diagonals. It permits hardness determinations of extremely thin metal, plated surfaces, exceptionally hard and brittle materials, exceptionally shallow carburized or nitrided surfaces or wherever applied load must be kept low. Indentation is measured on the long diagonal; is free from error due to "brink" effect because "ridging" or "sinking-in" around periphery of indentations in certain metals is absent at ends of long diagonal. Combination of light load and shape of "Knoop" indentation has little tendency to crack or spall brittle material. Long diagonal is little affected by elastic recovery when load is removed; short diagonal (not observed in usual hardness test) responds readily to elastic recovery and may be measured whenever recovered projected areas are to be considered. New tester applies loads that may be varied from 25 to 3600 grams and freedom from friction is said to be attained in a novel way. Furthermore the penetrator, though carried by a balance beam, always applies its load truly normal to surface tested, and at the fixed rate of 6.5 mm. a minute. Load remains applied for a definite period. New "Tukon Tester" is fully

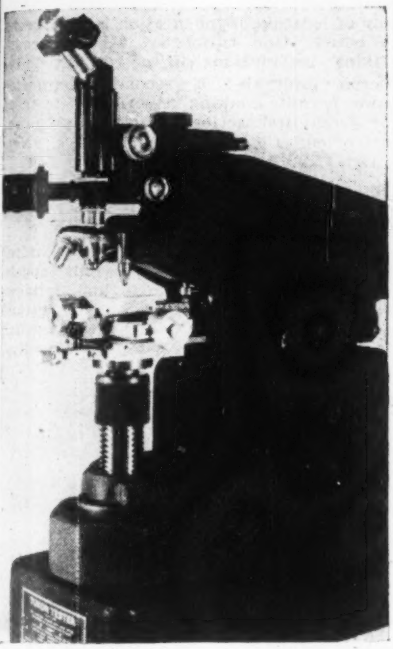


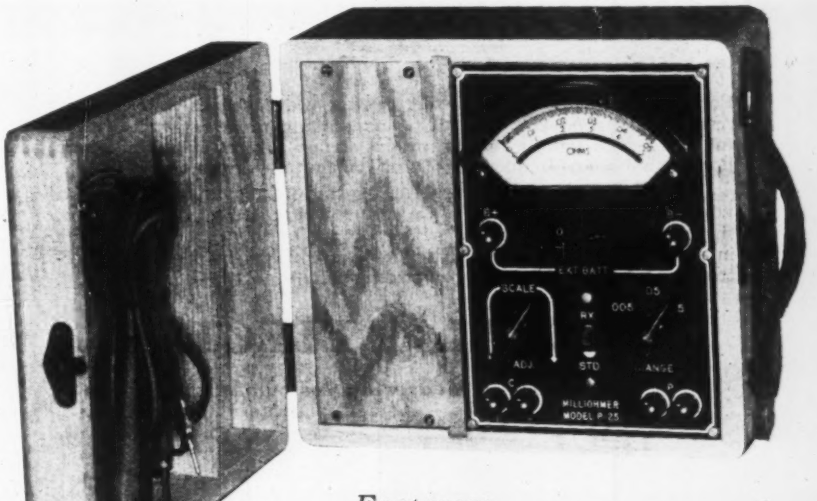
Fig. 1

The New Model P-25

A DIRECT READING
LINEAR SCALE

MILL-I-OHMER

Range: 1/20,000th of an ohm to ½ ohm.



Features:

- OPERATES ON SELF-CONTAINED BATTERY — NO EXTERNAL SOURCE OF CURRENT REQUIRED.
- COMES HOUSED IN HEAVY-DUTY OAK CABINET.
- MIRROR SCALE ON METER ELIMINATES PARALLAX ENABLING EXTREMELY ACCURATE READINGS.

Measures:

SWITCH RESISTANCE,

CONTACT RESISTANCE,

FRACTIONAL OHM STANDARDS, ETC. ! !

INDISPENSABLE IN THE QUANTITATIVE ANALYSIS OF ALLOYS BY THE RESISTANCE CHECK METHOD! !

INSURES RAPID ACCURATE BOND TESTING! !

Specifications:

- 3 Ranges: 0 to .005/.05/.5 Ohms (Each division on Low Range equals .00005 Ohms.)
- Accuracy —1% or better *at any point.*
- The built-in standard resistors are all of the 4 terminal type and are individually adjusted to an accuracy of ½ of 1%.
- Circuit employed is exclusive adaptation of the potentiometric method of low resistance measurement.

The Model P-25 comes complete with test leads and all instructions. Size 6"x8"x9".
Net Price **$49.50**

Superior Instruments Company

227 FULTON STREET **DEPT. I** **NEW YORK 7, N. Y.**

WIDE-BAND OSCILLOSCOPE

For precision measurements and viewing wave shapes in electronic research and production testing. A nine-inch cathode-ray tube with a full 4 x 4-inch picture makes this instrument especially useful where both high and low frequencies of small magnitude are present.

Other units in the new General Electric line of ELECTRONIC MEASURING EQUIPMENT include: G-E wave meters, capacitometers, power supplies, square wave generators, signal generators and various other instruments in the ultra-high frequency and micro-wave fields for measuring electronic circuits and checking component parts.

GENERAL ELECTRIC

164-C12

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WATER LEVEL and FLOW RECORDERS

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At the press of a button, Moisture Register detects and measures moisture by the use of electronics.

Calibrated with a direct percentage reading dial, with a range from zero to 25 per cent. Completely portable and self-contained. Anyone can operate it.

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MOISTURE REGISTER CO.

133 N. GARFIELD AVENUE, ALHAMBRA, CALIF.

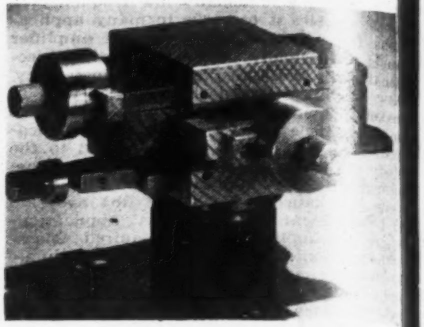
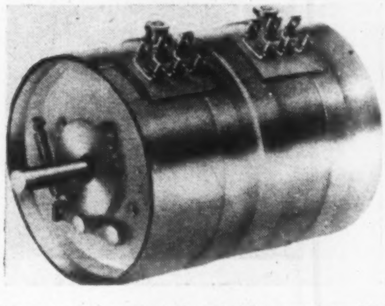


Fig. 2

automatic, may be equipped with bracket to support the microscope directly on a new type cowl. A Bausch and Lomb microscope and appurtenances can be supplied. (For duration of war, inclined eyepiece shown in photo cannot be supplied but it may be purchased later when B&L Co. are in position to furnish it.) *"Microton."*—Fig. 2 shows new special high-precision stage for making indentations in small areas. Accuracy of location of indentation is 10 microns or better. One calibrated screw permits making indentations in a row at ≧10-micron intervals; a second micrometer screw permits making a series of tests at 90° from first series.—*Wilson Mechanical Instrument Co., 383 Concord Ave., New York 54, N. Y.*

Dual-unit Attenuators

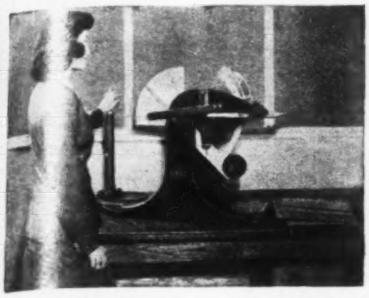
New model of "Dual-Unit Attenuators" is electrically the same as previous models. In addition it has fungus- and mildew-resisting varnish on all Bakelite parts and resistive windings. Contact and switch blades are of tarnish-resistant silver alloy.



Other metals are optional. Means of coupling front and rear attenuator shafts is simple, positive, durable and fool-proof. Among features: (1) Separable coupling — Front and rear units easily separated; gives quick access to either unit. (2) Improved shielding—Sturdy, snug-fitting, 3-piece steel cover. (3) Greater compactness—Rear of panel depth only 3⅞"; $\frac{9}{16}$" less than former models.—*The Daven Co., 191 Central Ave., Newark, N. J.*

Puncture Tester for Boxboard, Plywood, etc.

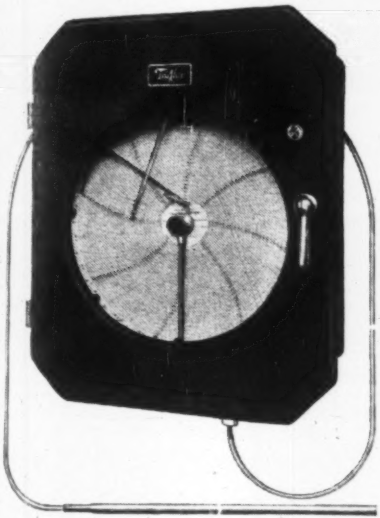
Redesigned puncture tester incorporates changes recommended by Institute of Paper Chemistry, has been adopted as a tentative standard by ASTM (Ref. D781-44T). Tester measures resistance to both puncture and bending of fibreboard, corrugated board, plywood, and other types of container materials. Retaining general lines and functions of previous model (see *Instruments*, Oct. 1943, pages 651-652) new tester is safer, tests more diversified grades of board with greater accuracy, is mounted on a firm cast-iron standard. Scale is now stationary and pointer independent of pendulum, minimizing possibility of deflecting pointer by jarring. Stationary scale, with



pointer held at correct scale value by a simple friction bearing, is easier to read. When auxiliary weights are mounted on pendulum for testing heavy grades of container material, scale zero can be checked quickly by removing a subassembly. Release mechanism, now operating at end of the pendulum rather than near its center of rotation, is so constructed that it latches pendulum securely in horizontal position. A clear plastic safety guard, mounted above clamping plate, prevents too close an approach to moving point of pendulum.—*General Electric Co., Schenectady, N. Y.*

Locker-room Recording Thermometer

New recording thermometer has been specially designed to meet increasing demand among food locker-room operators for unquestionable records of temperatures maintained in the cold room. Many states require use of a recording thermometer; in others, legislation is being considered. Chart provides operator with irrefutable evidence of temperature maintenance in case of damage claims. Publicity-wise operators can place new instrument where record is readable from street, even though instrument is 100 feet away from bulb inside locker room, because "Accuratus" tubing compensates for ambient temperature.—*Taylor Instrument Companies, Rochester, N. Y.*



Mobile Rectifier Unit for Magnetic Testing

New mobile rectifier unit for magnetic testing has a continuous capacity of 1500 amperes d.c. with proportionately higher rating for intermittent operation. Output voltage is adjustable in eight steps from one to six volts. A fan-cooled selenium rectifier assembly is heart of unit. "Rainproof" louvres at each end provide for air intake and exhaust. D-c. output terminals on each side, and control panel, are located in recesses in cabinet walls. Control

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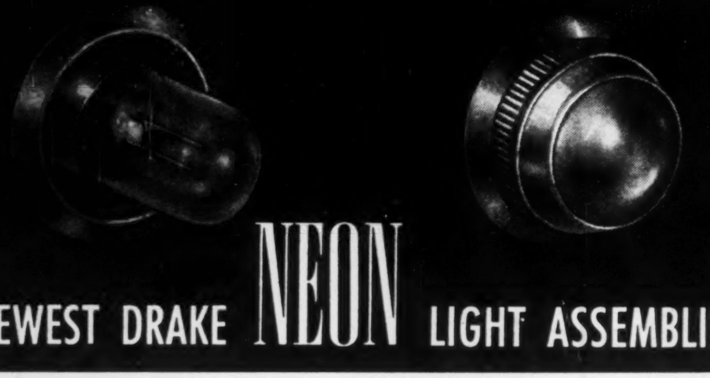

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DEPENDABLE SERVICE
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Drake No. 50N NEON Jewel Min. Bayonet Assembly is ideal where a distinct signal is required and observer is directly in front of instrument panel. Its ½" smooth clear jewel magnifies and intensifies the illumination from the Neon lamp. Red glass jewel can also be supplied. The No. 51N (without jewel) is applicable where 180° visibility is desirable. Both units have *built-in resistors* for NE51 Neon Lamps operating on standard 105 to 125 volt circuits. These rugged units offer BIG savings in power (1/25 watt), long life (3000 hours), wide voltage range, and great reliability.

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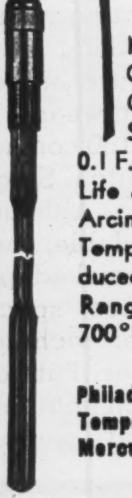

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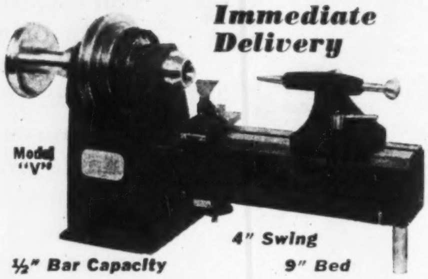

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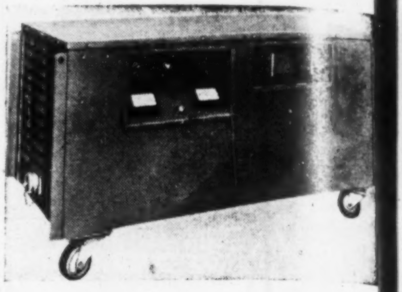
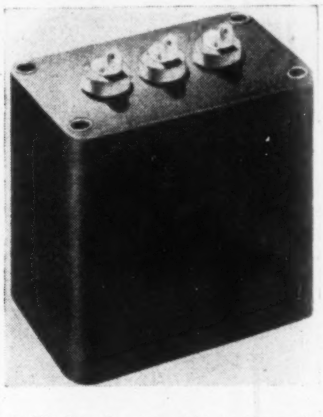


panel is equipped with fan starting switch push buttons for main contactor contro voltage adjustment switch, pilot lamp, visual and audible overload warning signals voltmeter and ammeter. Except for th fan which may be externally lubricate through Alemite fittings) there are no moving parts. If inspection is necessary, entir top of cabinet can be removed. Unit i mounted on heavy-duty rubber-tired swive wheels. Sling holes at the four upper corners permit crane handling.—*W. Gree Electric Co., 130 Cedar St., New York 6 N. Y.*

Interstage Filters

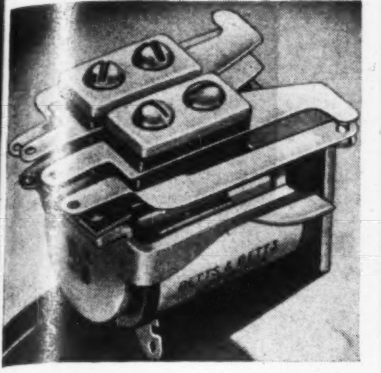
New "Type B.P.I." and "Type B.P.L." interstage filters lend themselves to effecting gain simultaneously with their frequency discrimination. Unit illustrated is a band pass unit which provides a 2:1 step-up



ratio, with band pass attenuation of 40 db per octave. This unit employs a dual alloy magnetic shield which reduces inductive pick-up to 150 mv. per gauss. Dimensions (in hermetically sealed case) 1½" × 2½" × 2½". Filters of this type can be supplied for any band pass frequency from 200 to 10,000 cycles, are adjusted to zero phase shift at the mean frequency.—*United Transformer Co., 150 Varick St., New York 13, N. Y.*

Telephone Type Relays

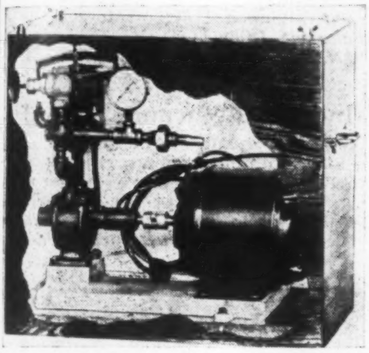
New "Type RAC" midget type relays are especially designed for communication, electronics and aviation applications. Units meet AAF tests for altitude, vibration, shock, humidity and extreme temperatures; are only 1 7/16" long, 1" wide and 1 1/16" high including first two pairs of contacts. Each additional two pairs of contacts add ⅛" more. Weight 1¾ oz. Coils are protected against moisture, corrosion and electrolytic action and have voltage range from 1½ to 70 volts d.c. A highly efficient magnetic circuit permits operation with ±25% voltage fluctuation. Insulation is inorganic-base plastic for minimum high-frequency loss and extra mechanical strength. Every unit is subjected to a 1,000-volt breakdown test. Any arrangement of contacts can be supplied for making, breaking or both up to twelve contacts. Contact springs are of fatigueless alloy with over-all welded silver



ontact surfaces. Sufficient back pressure ssures dead beat positive wiping action. ontact capacity 2 amps. at 100 watts.—*etts & Betts Corp., 551 W. 52nd St., New ork 19, N. Y.*

Portable Units for Air or Gas Testing

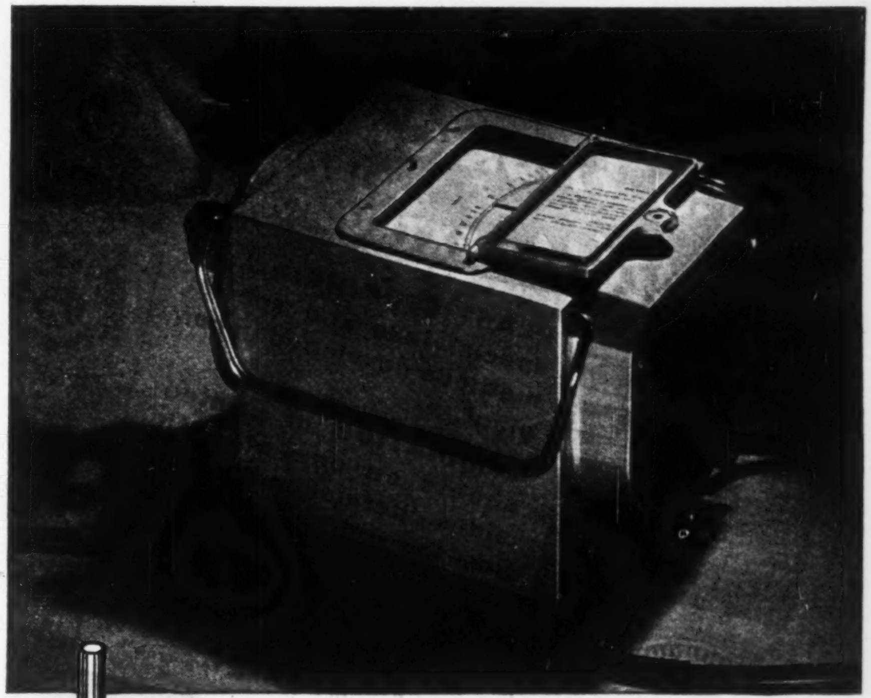
New vacuum and pressure units for gas r air, to be used in operating apparatus for emporary use or for test purposes, are vailable in several capacities, will handle

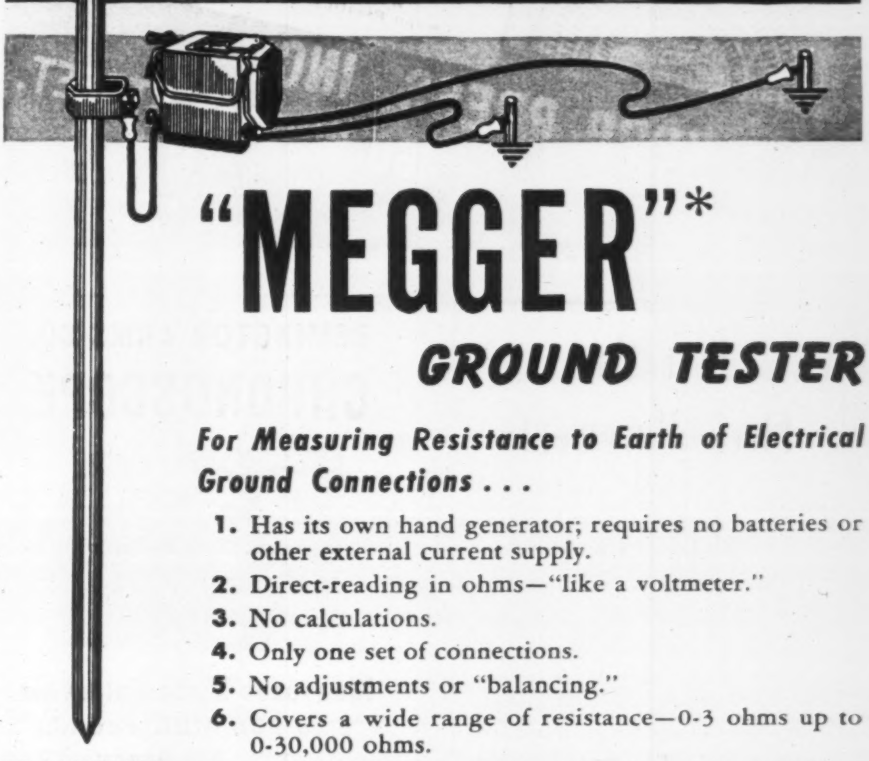


rom 1 to perhaps 5 cubic feet of air at a ressure up to 10 lbs., or 20″ mercury vacum. Any purpose for which air or noncorrosive gas might be used may be accomplished. Units may be made as light as 10 r 20 lbs. in weight; may be furnished as mall as about 6″ × 10″ and as low in eight as 6″ to 8″; may be equipped with nterchangeable motors for various currents ound in different sections, and while some re direct-connected to motor shaft, others re operated with V belts and grooved pulleys. Units are provided with means of controlling flow of air to or from the pump nd controlling pressure or vacuum.—*Leiman Bros., Inc., 185-77 Christie St., Newark , N. J.*

Optical-method Parallelism Checker and Comparator

New "Acme Light-wave Parascope" is especially designed for measuring the parallelism of seal rings and similar objects and to determine the change of parallelism under any desired pressure; may also be used for measuring the comparative heights of objects (such as balls for precision bearings) which must all be the same size within a few millionths. In general, to measure parallelism, the work is laid on an optical flat with another optical flat placed on top. Entire assembly is then set on table of instrument. Looking into eyepiece, operator sees interference fringes and need only count them and multiply by 10 to determine out-of-parallelism in millionths. New instrument can also be used for making usual light-wave check for flatness: straight bands if the surface is flat, curves showing devia-





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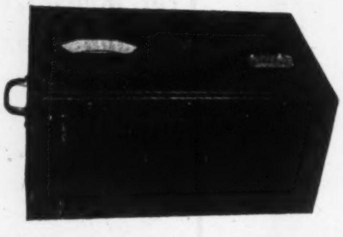

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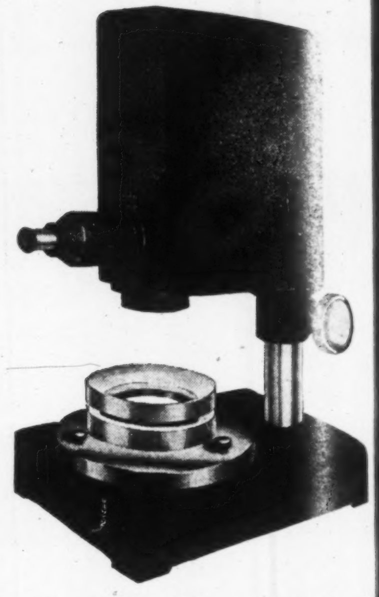


tions from flatness. "Parascope" illustrate will measure work up to 6" diameter an ½" thick. (Other sizes and greater thick nesses special.) Instrument comes complet with built-in light source and transforme for operation on 110-120-volt 60-cycle a.c —*Scientific Division, Acme Industrial Co 200 N. Laflin St., Chicago 7, Illinois.*

Industrial Vacuum Recorder

New "Model MR Televac" is for indicat ing and recording vacuum within range o 1 to 500 microns. Measuring element (close up in Fig. 2), known as "Televac 500 Ther mal Gauge," is said to represent "a ne development in the field of vacuum measure

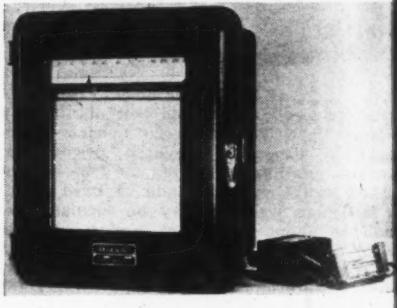


Fig. 1

ment." This gage contains filaments cov ered with a protective coating said to mak them immune to contaminating vapors suc as oil, water, mercury, etc., usually foun in vacuum systems. Thus the calibration i said to be constant under all normal oper ating conditions. Increased sensitivity i said to be gained by the use of two fila ments in both the reference and measurin

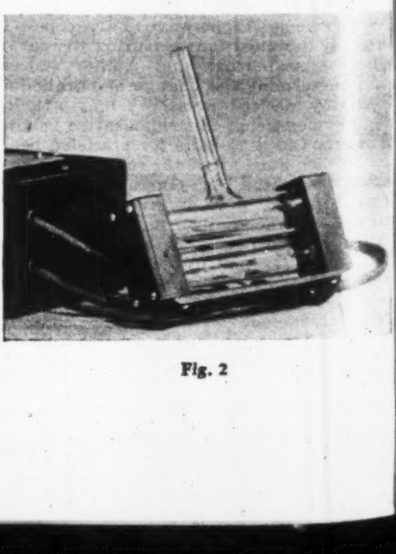
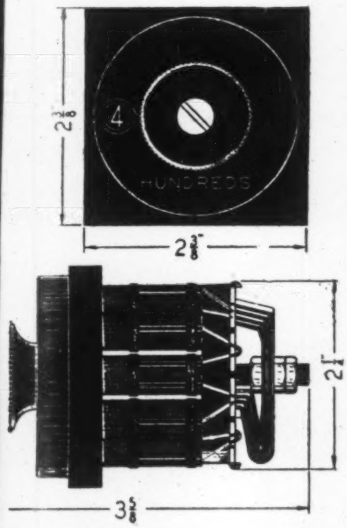


Fig. 2

es. All 00 Thermal Gauges" are interangeabl without recalibration and have indefini life, it is said. Filament curt is sup lied through calibrated coils in ies with he secondaries of a transformer. strumen operates on 110-volt a.c. which supplie through a voltage regulator unted i recorder cabinet, so that there e no fil ent currents to be adjusted in der to tain a correct reading. Instruent is s d to be easy to install and to quire n special operational care. It can ord va a in several systems simultanesly by ans of a multiple-point recorder throug a selector switch. (For accute reco s below 1 micron, down to 10^{-6} m. Hg. aker's "Model S Televac" is recmende) — *George E. Fredericks Co., thayres, Pa.*

Decade Resistance Assemblies

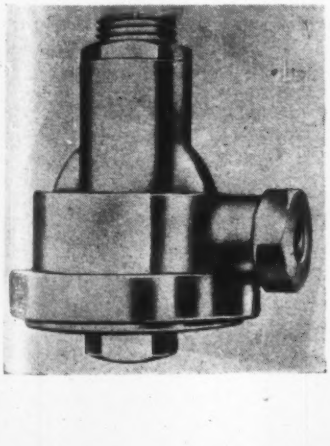
New individual decade resistance assemies are chiefly designed for incorporation instruments and apparatus for accurate ssurement or control of electrical magnides. Coils are of bifilar construction, suit-



d for commercial-frequency a-c. work as ell as d-c. work. (Maker can supply reistors as designed by Dr. Frank Wenner r higher frequencies.) *Accuracy:* Limit error for 0.1-ohm resistors is 0.25%; for l others 0.1%. Two or more decades hich are to be used together may be had ounted and interconnected on a single anel, when so specified on order. Six asemblies make up series: from 9 × 0.1 ohm 9 × 10,000 ohms.—*Rubicon Co., Ridge ve. at 35th St., Philadelphia, Penna.*

Pressure Switch

New "Pressure-Clix" provides instant ake and break of electrical contacts when ressure drops below or goes above setting. Body is of rugged construction with ⅛" ipe connection in base. Heavy-duty elec-



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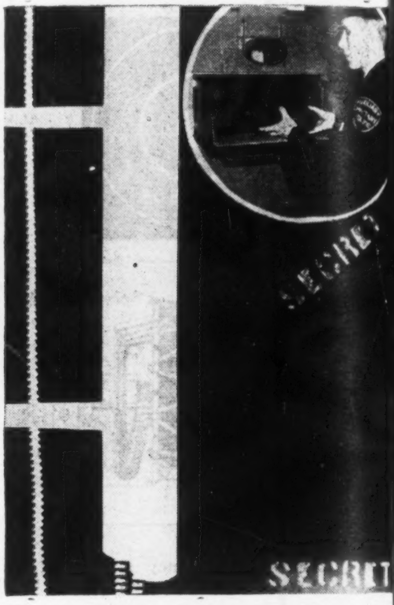
tric cable connection enters through sid and is secured by compressed rubber grommet to protect connection to switch. Adjustable screw and locknut provide an eas means of adjusting pressure setting. Al gases, oil, fuel and other liquids can b handled, as diaphragm is of special resist ant material. Springs and other parts ar said to be of highest quality assuring year of accurate service. Overall dimension 3″ × 2¼″ × 2⅝″. Weight in brass 16 oz in aluminum 8 oz. Normally-off or normally on contacts supplied as specified. Availabl ranges 0-3, 3-10, 4-19 and 2-28 lbs./in. with differential settings adjustable i oz./in.^{2}. Various switch voltages and capaci ties, including high-altitude service to 40,00 ft. for aircraft applications.—*Hawk Tool Eng'g Co., 7663 Epworth Blvd., Detroit Mich.*

X-ray Compound for Secret Documents

New marking compound can now be use to mark secret documents. Photo shows ho such a paper, marked with the compound



looks in "Norelco Searchray" industria x-ray unit: the secret paper was hidden i a stack of literature 1½″ thick and was enclosed in a zipper bag. Insert view at uppe right shows a plant guard placing the ba into the compartment of "Searchray 80" unit.—*North American Philips Co., Inc. 100 E. 42nd St., New York 17, N. Y.*

D.-c. Industrial Analyzer

New d-c. industrial analyzer is said to provide, in one compact light-weight case, all the ranges necessary for testing d-c. motors from ½ to 600 hp. and industrial

and marine electrical equipment such as generating and distribution equipment or control devices. Voltmeter has a self-contained range of 15-150-300-750 volts with a sensitivity of 200 ohms per volt. Ammeter ranges of 7.5, 75, 750 amperes are available through heavy all-metal binding posts located at top of panel. Both instruments have an accuracy of 1% of full-scale value and a scale length of 3½". The ammeter has a separate 0-50-millivolt range which is available through external binding posts allowing the use of external shunts to provide additional ampere ranges when desired. The instruments are mounted on a polished black Bakelite panel in a durable wood case 7¼" × 11" × 13½" covered by black leatherette with metal corners.—*Cole Instrument Co., 1320 S. Grand Ave., Los Angeles 15, Calif.*

Direction-indicating Compass

New "Type 2223" direct-reading "Autolight" Magnetic Direction Indicator Compass, said to be the smallest and lightest of its kind, is particularly adapted to private aircraft and gliders. Azimuth pointer rotates in front of a fixed dial, making new compass exceptionally easy to read. Instrument uses a standard 1⅞" luminous dial, graduated every 5°, and combines a short time of swing or period with a low value of overswing and a high lateral dynamic stability—characteristics said to result in quick response. Entire mechanism is permanently immersed in compass fluid, thereby assuring complete absence of mechanical friction. Wide-range temperature and magnetic compensation are provided within housing, and each instrument is provided with a nonmagnetic adjusting screwdriver. Total weight is 6 oz.—*G. M. Giannini & Co., Inc., 161 E. California St., Pasadena 5, Calif.*

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Salient features: Permanent film or paper record up to 10" wide and 200' long — top panel control — constant speed within ½% at the desired value — simultaneous viewing while recording — 15 speeds from 120" to 1" per second — time coordinate lines photographed across record as taken, with 1/100 to 1/10 second interval.

Automatic successive numbering device — title photographed on record — constant impedance attenuators in each channel — electromagnet shutter opens recording compartment while recording, closes it after each record — internal heater permits use in low ambient temperatures.

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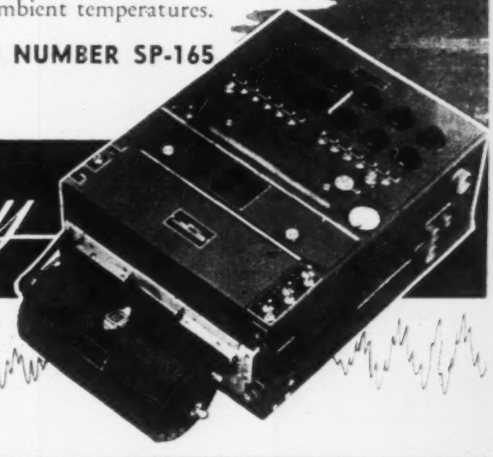
Hathaway



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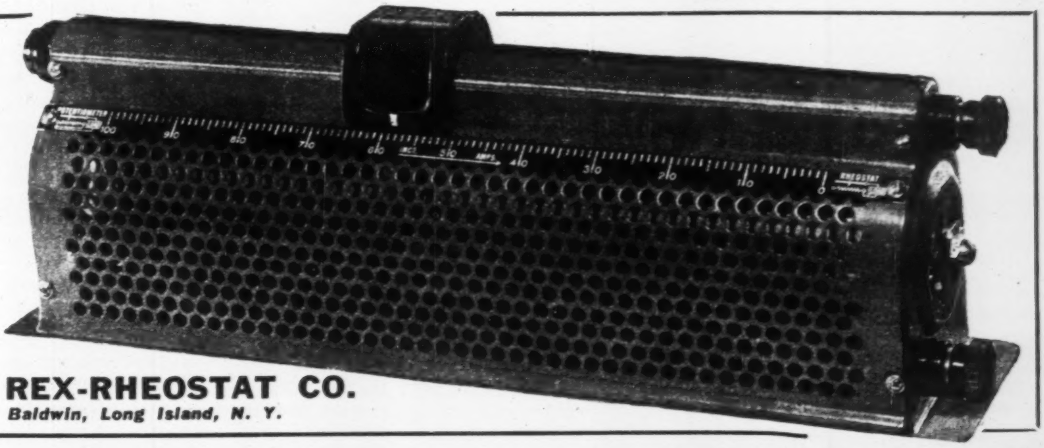

REX-RHEOSTAT CO.
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INSTRUMENT SOCIETIES CALENDAR

City, Society and Secretary			Date	Place	Subject	Speak
Atlanta	Georgia Society for Measurement & Control	Roger W. Allen, 376 Nelson St., S.W., Atlanta	Nov. 27(B)	Ellen Rice Tea Room	(To be announced)	
Baltimore	Baltimore Industrial Instrumentation Society	J. J. Segleto, 35 S. Potomac St., Baltimore 24, Md.				
Chicago	Chicago Society for Measurement & Control	A. J. Butler, 2626 W. 31st Blvd., Chicago	Jan. 8(B)	Merchants' & Mfrs' Club, 237 M. Mart	Telemetering	P. A. Borden Bristol Co.
Cleveland	Cleveland Instrumentation Society	W. A. Stubblefield, 2085 W. 104th St., Cleveland 2	Dec. 27(B)	Cleveland Engineering Society	Oxygen Recorders	J. F. Luhrs
Fort Worth	Fort Worth Electronics Club	Ralph Ely, 1116 E. Arlington, Fort Worth, Tex.	Dec. 21(A)	Texas Hotel	Telemetering	H. R. McKenzie, Texas Electric Service C
Gulf Coast	Gulf Coast Instrument Maintenance Men's Ass'n	T. H. Pierson, 3030 Roberts St., Beaumont, Tex.				
Hartford	Hartford Society for Measurement & Control	S. J. Zelle, Bridgeport Thermostat Co., Inc., 1225 Connecticut Ave., Bridgeport, Conn.				
Kansas City	KC Industrial Instrumentation Society	Gordon H. Burke, 1527 Broadway, Kansas City, Mo.	Dec. 19(B)	Bluebird Cafeteria	Instrumentation of H.F. alkalation units	C. E. Defabaugh, Phillips Petroleum Co.
Newark	New Jersey Society for Measurement & Control	Robt. H. Gray, 1 Whippoorwill Way, Mountainside, N. J.	Jan. 2(B)	Essex House	Combustion Protective Control	D. A. Campbell Bryant Heater Co.
New York	New York Society for Measurement & Control	H. R. Kalbfleisch, 144-35 No. Blvd., Flushing, N. Y.	Dec. 26(B)	Men's Faculty Club Columbia Univ., 400 W. 117th St.	Present trend in industrial electronics	Keith Henney, Editor of *Electronics*
N. Indiana	Northern Indiana Soc. Measurement & Control	R. W. Schreiner, 4 Waltham St. Calumet City, Illinois				
Philadelphia	Philadelphia Society for Instrumentation	J. E. Gambrill, 1317 Spruce St.	Dec. 20(B)	Engineers Club 1317 Spruce St.	Manometer Applications in Industry	A. A. Hejduk, Meriam Instrument Co.
Pittsburgh	American Society for Measurement & Control	L. M. Susany, c/o Carnegie Institute, 4400 Forbes St., Pgh.	Dec. 18(B)	Roosevelt Hotel	Dimensional Control as an Economic Force	I. A. Hunt, Federal Products Corp.
			Jan. 22(B)	Roosevelt Hotel	Liquid-in-Glass Thermometry	W. D. Laverell, Precision Thermometer & Inst. Co.
St. Louis	St. Louis Society for Instrumentation	Gus Holubeck, Union Electric Co., Venice, Ill.				
Toronto	Canadian Society for Measurement & Control	T. C. Agnew, Minneapolis-Honeywell Reg. Co., Toronto				
Washington, D. C.	Instruments Society of Washington	W. A. Wildhack, 328 N. Oxford St., Arlington, Va.	Dec. 19(D)	Interior Dep't Auditorium	Instrument Work in Government Agencies	Heads of Several Laboratories
Wyandotte, Mich.	Instrument Society of Wayne County	D. J. McCloskey, 116 Oak St., Wyandotte, Mich.				

(A)Meeting at 7:30, no dinner. (B)Dinner at 6:30, meeting at 8. (C)Dinner at 7, meeting at 8. (D)Meeting at 8, no dinner.

CALIFORNIA INSTRUMENT SOCIETY BEING FORMED

On Tuesday Evening, November 14, a meeting was held at the Hotel Mayfair in Los Angeles, California, for the purpose of discussing the organization of a society of those persons in the Los Angeles Area who are interested in instrumentation.

This meeting was the result of the work of a Temporary Organizing Committee which had gotten together a month previously. This group elected Mr. Wm. B. Warren as Chairman and was composed of the following:

Wm. B. Warren, Intertechnical Associates, *Chairman*
R. P. Gallien, R. P. Gallien Co.
R. G. Leitner, Frank Rieber, Inc.
W. K. Rieber, Frank Rieber, Inc.
F. H. Cole, Jr., Cole Instrument Co.
M. D. Pugh, Instruments Publishing Co.
J. W. Culbertson, Technical Instrument Laboratory.
Stuart Wilcox, Technical Instrument Laboratory
W. M. Mercer, Technical Instrument Laboratory
W. E. Wright, City of Los Angeles
J. F. Drescher, Pyramid Const. Co.
H. R. Abey, Leeds & Northrup

At the meeting, which was preceded by an excellent duck dinner, approximately 100 persons discussed the matter of the need for such an organization, what its aims should be, the type of programs desired, and the business of more complete organization.

Eventually, the Temporary Organizing Committee was authorized to continue with the business and to form committees for that purpose.

Under this mandate from among the electorate, Mr. Warren appointed the following committees:

Constitution: Mr. Pugh, Chairman; Messrs. Richards, Wilcox, and MacNamee.

Finance: Mr. Cole, Chairman; Messrs. Culbertson, Balderston, and Hansen.

Membership: Mr. Gallien, Chairman; Messrs. Rieber, Drescher, and DeLeon.

Program: Mr. Leitner, Chairman; Messrs. Angelo, Wright, and Cary.

These committees are to report at a subsequent meeting to be called by the Program Committee within the next month.

—Wm. B. Warren

NEW JERSEY AND NEW YORK

The joint meeting of the New York and New Jersey Societies for Measurement and Control was held on the 14th of November with a total of 80 members attending from both societies. Dr. R. B. Sosman of the U. S. Steel Corp. talked about "Pyrometry in the Steel Industry." This was a very valuable and unusual lecture as Dr. Sosman omitted remarks about instrument construction and design, and concentrated on where and how temperature measurements are made in the manufacture of steel. The importance and method used to obtain temperature readings in the various phases of the processes and what was done with or about these readings was explained. Nearly all temperature readings fall into one of the following four classes: (1) Apparatus protection; (2) Supervision; (3) Intelligent control; (4) Automatic control.

Various pieces of apparatus were used to demonstrate some points while other points were explained with the use of slides. During the discussion period Dr. Sosman answered many questions for members of both societies.

Our speaker for the December meeting will be Keith Henny, Editor of Electronics and his topic will be "Pertinent Trends in Industrial Electronics."

We will not hold our usual monthly meeting on the 27th of December as the above joint meeting replaced it.

—H. R. Kalbfleisch

WASHINGTON

At the November meeting of the Instrument Society of Washington, Mr. C. G. Vienott, Special Development Engineer of Westinghouse, gave an illustrated talk on "Characteristics and Applications of Fractional-horsepower Motors," discussing the relationship between characteristics and application requirements in instrument and scientific uses.

A short color motion picture, "West Lynn," prepared by the General Electric Company was shown following the address.

—W. A. Wildhack,
Corresponding Secretary.

Tentative Plans Made to Resume Appalachian Gas Measurement Short Course in 1945

The General Committee of the Appalachian Gas Measurement Short Course held a two-day meeting on August 25 and 26 at the School of Mines, West Virginia University, Morgantown, W. Va. An important business of the committee was planning for the resumption of the Appalachian Gas Measurement Short Course which is normally conducted annually by the School of Mines, West Virginia University in coöperation with the Public Service Commission of West Virginia, the West Virginia Oil and Natural Gas Ass'n, the American Gas Association and the industries concerned in producing and marketing oil and natural gas and in manufacturing, metering and regulat-

ing apparatus in West Virginia and surrounding states. Owing to the effects of the War Effort it became necessary to suspend the annual Gas Measurement Short Course during 1942, 1943 and 1944. At this meeting the general committee, after considering the satisfactory progress of the war, proceeded to lay tentative plans for the resumption of the Gas Measurement Short Course in 1945.

In addition to considering plans for the 1945 short course, technical sessions were held. At these sessions the following papers and reports were presented:

Designing and Installing Measuring and Regulating Stations. Report No. 3 of the Practical Methods Committee, C. B. Heist, Chairman.

New Developments in Measurement of Pulsating Flow, S. R. Beitler.

Extension Program of the School of Mines, West Virginia University, for Employees of the Natural Gas Industry, George McKinley.

Gas Supply in West Virginia, H. J. Wagner.

The Operation and Testing of Large Capacity Displacement Meters in the Field, John L. Galpin and Walter L. Smith.

"FUEL SAVING STARTS WITH CONTROL"

"War has increased coal requirements to the extent that the mines no longer can meet them under existing conditions.

"Unless consumers, through vigorous fuel-saving measures, reduce their requirements sufficiently to close the gap between what we can produce and what we shall need, we shall be confronted with an acute coal emergency next winter.

"Under present conditions and trends, the mines are not expected to produce more than 647,000,000 tons of coal during the fuel year from April 1, 1944, to March 31, 1945. Our coal requirements for that period, based upon our wasteful fuel-consuming practices, are estimated at 685,000,000 tons. We are threatened with an obvious coal deficit of 38,000,000 tons.

"It has been demonstrated by experience that consumers can save substantial amounts of coal by the proper maintenance and operation of their heating equipment. . . . The installation and the proper use of automatic heat controls rank high on the list of things that people could do to save fuel. I am glad to learn that the Automatic Controls Industry is vigorously discharging its wartime responsibility to the Nation by proceeding at once with a comprehensive fuel conservation program."—Harold L. Ickes, Solid Fuels Administrator for War.

"The conservation of fuel used for heating and power has become one of the Nation's most important duties. Transportation requirements of our Armed Forces and for war production are so vast that every possible reduction in the requirement of transportation for movement of fuel must be assured.

"Many competent authorities have stated that probably 20% of all fuel burned in small industrial plants, and up to 40% of that burned in the average heating plant, is wasted. This waste is caused in industrial plants by lack of efficiency in boiler operation, and in heating plants by the same lack of efficiency plus the additional loss due to overheating. The average heating and power plant can eliminate the greater percentage of fuel waste by choosing equipment wisely and by maintaining rigid operating standards.

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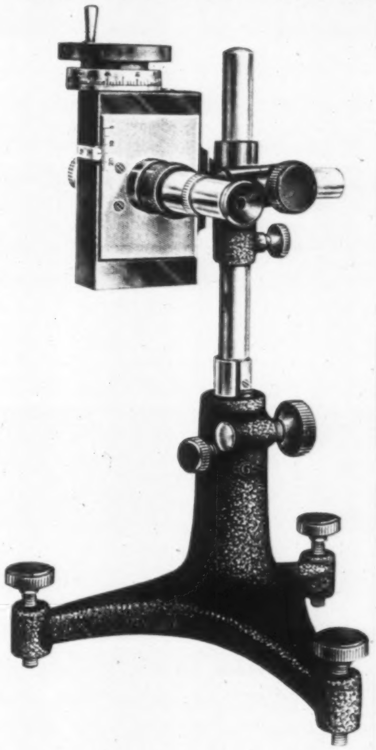

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Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from th manufacturers. To assist in the War Effort we urge readers to request ONLY those bulletin which will be of value to them. Use the coupon on the facing page.

L-226 **Aviation Tube Working Tools.** Bulletin No. 800, 8½″ × 11″, 2 pages, describes tube cutters, benders, and sawing devices. Tube cutters (overall length 6⅝″) are designed to make clean right angle cuts necessary for perfect A-N type flares, will cut aluminum, aluminum alloy, copper, brass, or steel aircraft tubing in sizes from ⅛″ to 1½″ O.D. Cutting tool includes a reamer to remove burrs from tubing. A smaller type cutter will cut same type of tubing but takes sizes from ⅛″ to ¾″ O.D. Tube benders (any angle up to 180°) are for tubing from ⅛″ to ⅝″ O.D., but a different bender is required for each size of tubing. Photographs supplement information and specification tables. The Imperial Brass Manufacturing Co., 1200 W. Harrison St., Chicago 7, Ill.

L-227 **Vibration Fatigue Testing Machines.** Bulletin 210, 8½″ × 11″, 4 pages, features specifications on a unit designed to test parts up to 10 lbs. weight. Vibration in simple harmonic motion is produced vertically, and acceleration of vibration can be changed uniformly and continuously from 10 to 55 cycles (over a period of a minute) by a geared fractional-horsepower motor operating a cam which in turn operates a speed-controlling device. Such automatic cycling can be maintained indefinitely until interrupted. Vibration can also be held or fixed at any desired frequency from 10 to 60 c.p.s., the desired frequency being selected manually. Text provides further data on this apparatus and on other units of a similar nature except for loading capacities. Individual cuts illustrate each machine. All American Tool and Mfg. Co., 1014 Fullerton Ave., Chicago 14, Ill.

L-228 **Interstage Filters.** 2-page 7¼″ × 10½″ bulletin describes units available for frequencies from 200 to 100,000 cycles. These filters are sharply peaked, with approx. 2 db attenuation at frequencies ± 3% from mean frequency and attenuations of approx. 40 db per octave. United Transformer Co., 150 Varick St., New York 13, N. Y.

L-229 **Pressure Switch.** 2-page 8½″ × 11″ bulletin describes "Pressure-Clix" which is available in ranges of 0-3, 3-10, 4-19 and 2-28 lbs./in.^{2} with adjustable differential. Feature is smallness (3″ × 2¼″ × 2⅝″ overall) and light weight (16 oz. in brass, 8 oz. in aluminum). Hawk Tool and Engineering Co., 7663 Epworth Blvd., Detroit 4, Mich.

L-230 **Time Meter.** 2-page 8½″ × 11″, bulletin describes a running-time or idle-time meter applicable to any a-c.-driven machine or equipment. Registers to 9999.9 hours and resets at 10,000 hours. Operates on 120-volts ±20%, 50- or 60-cycle as specified. Sales Engineering Associates, Inc., 3907 San Fernando Rd., Glendale 4, Calif.

L-231 **Boxboard Tester.** 2-page 8½″ × 11″ bulletin describes new model of puncture tester for fibreboard, plywood, very heavy paper and other container materials. This new model meets Army, Navy and ASTM specifications. General Electric Co., Schenectady, N. Y.

L-232 **Hardness Tester.** 4-page 8½″ × 11″ Bulletin TK-45 describes new highly refined model of "Tukon Tester" embodying diamond pyramid method invented by Dr. Knoop of the National Bureau of Standards. Wilson Mechanical Instrument Co., 383 Concord Ave., New York 54, N. Y.

L-233 **D-c. Solenoids.** Bulletin, 8½″ × 11″, 32 pages, contains photographs of Cannon Electric's full line of d-c. solenoids, together with tabular data, dimensional drawings, wiring diagrams and response characteristic charts. Introduction lists aircraft applications of d-c. solenoids, such as operating hydraulic valves and mechanical clutches, firing machine guns, arming and releasing bombs, releasing auxiliary fuel tanks and locking aircraft retracting gear. In other industries d-c. solenoids are adaptable for film-winding mechanisms and cameras. Cannon Electric Development Co., 3209 Humboldt Street, Los Angeles 31, Calif.

L-234 **Jewel Bearings and Jewels.** Booklet A, 8½″ × 11″, 16 pages, gives a general outline of the principal uses for jewels in industry. Properties of synthetic sapphires are included. John Worley Jewel Co., Waltham, Mass.

L-235 **Solderless Terminals.** Folder, 4″ × 9″, 12 pages, illustrates a number of terminal lugs for flexible stranding or solid wire. Krueger & Hudepohl, 3 East 3 Street, Cincinnati 2, Ohio.

L-236 **Fluxmeter.** Publication GEA-4157, 8¼″ × 11″, 2 pages, describes a search-coil type fluxmeter utilizing a light-beam galvanometer with suspension-type element, for measurement of d-c. magnetic fields which occur in research, testing, and production work. Suspension elements are interchangeable, and elements having a sensitivity of 1 mm. for 101 flux lines can be supplied. Accurate within ±1% of full-scale flux linkages by following recommended calibration procedure. General Electric Co., Schenectady, N. Y.

L-237 **Three-dimensional Vectographs.** Leaflet, 8½″ × 11″, 2 pages, describes equipment for producing photographs and lantern slides which, when viewed through Polaroid spectacles, are stereoscopic. Can be used to illustrate complex machinery and apparatus, microscopic views, X-ray pictures, engineering constructions, aerial views, etc. Text provides further details and contains a complete price list of necessary items. Polaroid Corp., 211 Massachusetts Ave., Cambridge, Mass.

L-238 **"Spring-life" Bellows.** Catalog BG-2-15, 8½″ × 11″, 44 pages, describes metal bellows for use in pressure regulators, valves, combination seal and piston, flexible couplings, pressure equalizers, thermostatic valves, etc. By means of a patented construction there is no limitation on flange diameter or number of flanges that can be joined. Text explains method of construction and the various properties of bellows that must be considered in design and application. Photographs and drawings illustrate nu-

erous types and show numerous appli-
tions. Specifications of various types
e listed in table form for quick selec-
on. Cook Electric Company, 2700 South-
rt Ave., Chicago 14, Ill.

L-239 **Fyrite" CO_2 Indicator.** Bulle-
n 341, 8½" × 11", 4 pages, describes a
st, simple indicator whereby a com-
ete CO_2 reading, accurate within ½ of
% CO_2 under all conditions, can be made
40 seconds. Bacharach Industrial In-
rument Co., 7000 Bennett St., Pitts-
rgh 8, Pa.

L-240 **Boiler Gas Fuel Regulator.** Bul-
tin 508, 8½" × 11", 2 pages, describes
ype G-1" having four-port valve con-
ruction, which will maintain uniform
eam pressure and regulate fuel to bur-
rs in accordance with steam demands.
or steam pressures up to 175 lbs./in.².
tural Gas Equipment, Inc., and Wilgus
fg. Co., Los Angeles, Calif.

L-241 **Type G-710 Microhmmeter.** Bul-
tin 432, 8½" × 11", 1 page, describes a
ndamentally sensitive electronic a-c.
idge which will measure from 0.0001
m to one megohm in four ranges. Ac-
racy ±2% on 0 to 1.111 range, and
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fficient to drive a recorder or sensitive
lay where it is desired to record or
ntrol temperature, moisture, pressure,
c. Tech Laboratories, 7 Lincoln St.,
rsey City 7, N. J.

L-242 **Industrial Timers.** Bulletin 4492,
½"×11", 4 pages. Describes eight en-
neering features of industrial timers
lustrated. Operating principles, specifi-
tions and price list are included. Para-
on Electric Co., 37 West Van Buren St.,
hicago 5, Ill.

L-243 **Tachometers.** Bulletin 44-1,
½"×8½". Descriptive folder covers four
odels of individual-mount tachometers
d the multi-range portable tachometer.
lustrations and prices are included.
nes Motrola Co., Stamford, Conn.

L-244. **Resistors.** Catalog, 8½" × 11",
pages. Illustrates and describes 4 types
resistors; includes table giving power
ire wound specifications. Contains prices
d coating specifications. Haines Manu-
cturing Corp., 248 McKibbin St., Brook-
n 6, N. Y.

L-245. **Relays.** Folder, 8½" × 11", 4
ges. Contents illustrates thermal re-
ys and also gives the major uses and
dvantages of the various types. Speci-
cations for unmounted units are in-
uded. Instrument Div., Thomas A.
dison, Inc., West Orange, N. J.

L-246. **Automatic Controls.** Catalog
0B, 8½"×11", 48 pages. Comprehensive
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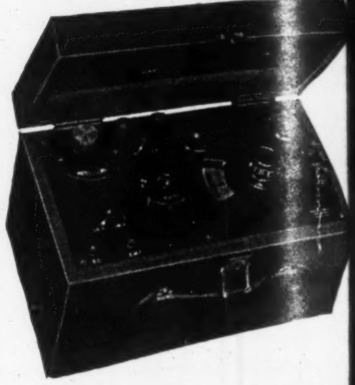

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ADVERTISERS' INDEX

Acro Electric Company........767
Aerovox Corporation...........A28
Air Express Div., Ry. Ex. Agency.....................753
All American Tool & Mfg. Co...773
Allied Radio Corporation......774
American Cystoscope Makers, Inc.........................770
American Gas Accumulator Co...790
American Instrument Company..792
American Lens Company........A7
American Time Products, Inc....A6
Ames Company, B. C...........774
Amthor Testing Instrument Co..792
Arnold Engineering Company...787
Associated Research, Inc.......784
Automatic Electric Mfg. Co....800
Bailey Meter Company..........782
Barber-Colman Company 792
Barbour Stockwell Company....764
Bendix Aviation Corporation Bendix Marine Division......781
Biddle Company, James G......797
Bradley Laboratories, Inc......777
Breeze Corporations, Inc.......A26
Bridgeport Thermostat Co......A23
Burgess Battery Company.......785
Canadian Radium & Uranium Corp.........................754
Chace Company, W. M.........763
Chelsea Clock Company.........798
Chicago Metal Hose Corp......757
Clarostat Manufacturing Co....778
Cochrane Corporation A8, A27
Conant Electrical Laboratories..799
Connecticut Tel. & Elec. Div...A11
Corbin Screw Corporation......804
Daven Company..Inside Back Cover
Dillon & Co., Inc., W. C......776
Dow Corning Corporation......A16
Drake Manufacturing Company..796
Du Mont Labs., Inc., Allen B..A24
Elgin National Watch Co......768
Eppley Laboratory, Inc., The...770
Federal Products Corporation...751
Fenwal, Incorporated 758
Fischer & Porter Company....A32
Fish-Schurman Corporation 772
Ford Motor Company, Johansson Div. 776
Foxboro Company, The........A10
Fulton Sylphon Company, The..A19
Gaertner Scientific Corp., The..803
Gallien, R. P. 796
General Electric Company..A13, 794
General Radio Company.......A18
Great Amer. Industries, Inc....A11
Guardian Electric A17
Hathaway Instrument Company.801
Hays Corporation, The.........766
H-B Instrument Company, Inc..766
Heise Bourdon Tube Labs......760
Hewlett-Packard Company A36
Hickok Electrical Instrument Co. 783
Holtzer-Cabot Div., First Industrial Corporation ....Insert
Hopp Press, Inc., The.........798
Illinois Testing Labs., Inc......756
Indiana Steel Products Co., The.A22
Jack & Heintz, Inc.........A14-A15
J-B-T Instruments, Inc........791
Johansson Div., Ford Motor Co..776
Kelnor Manufacturing Company.753
Kester Solder Company 759
Kollsman Instrument Division..A3
Leeds & Northrup Company....A38
Leupold & Stevens Instruments.794
Lewis Engineering Company.....A5
Liquidometer Corporation 760
Littelfuse, Incorporated 790
L & R Manufacturing Co.......762
Mead Specialties Company.....756
Measurements Corporation .... Back Cover
Meriam Instrument Co., The...761
Merit Coil & Transformer Corp..758
Mine Safety Appliances Co.....775
Moeller Instrument Company...765
Moisture Register Company....794
Morey & Jones, Limited.......806
Ohmite Manufacturing Co......748
Palmer Company, The.........
Paragon Electric Company.....
Permo, Incorporated ....
Philadelphia Thermometer Co...
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VOL. 17, NO. 9 SEPT. 1944 PART TWO

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THE 1944 Instruments INDEX

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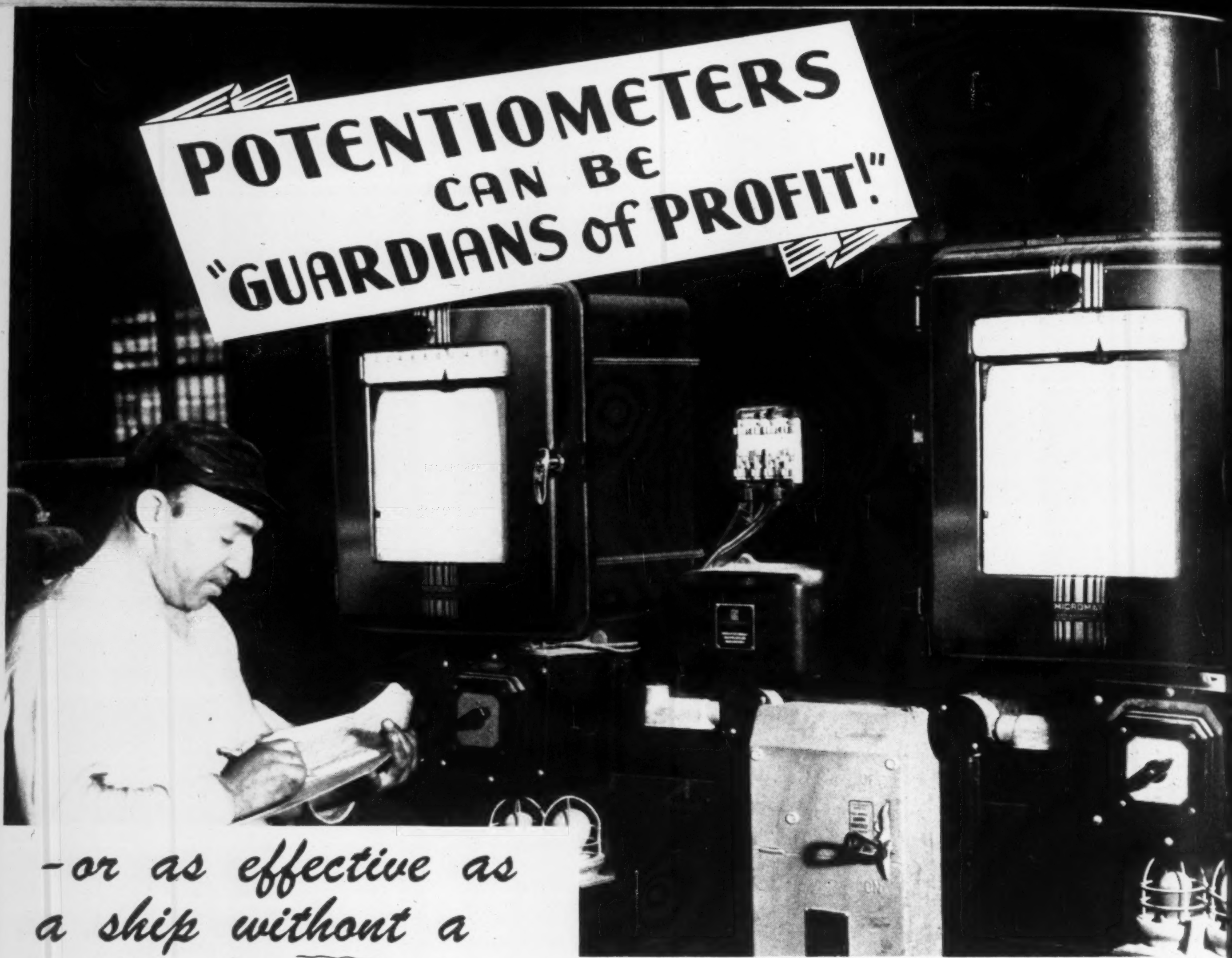

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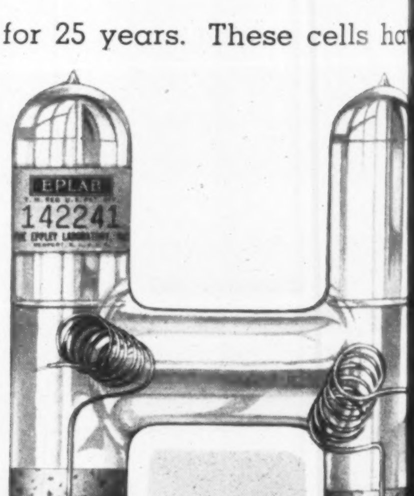

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PECIAL ISSUE OF

Instruments
THE MAGAZINE OF
Measurement and Control

ol. 17 FEBRUARY 1944 No. 2

n Two Parts

ART TWO–

HE 1944 NSTRUMENTS NDEX

CONTENTS

. *Index to Instruments and Apparatus.* **In this section, prod-ts are listed alphabetically. Under each heading appear names of the manufacturers of this equipment (and of sole representatives of such manufacturers).** *Pages 10 126.*

. *List of the Laboratory Supply Houses.* **Under the heading pparatus, Laboratory," on page 14, are listed companies ecializing in laboratory supplies, equipment, instruments d apparatus.**

. *Directory of Manufacturers and sole representatives,* **with mplete addresses and brief descriptions.** *Pages 127 to 139.*

. *Index to Advertisers in this Section. Page 140.*

Published Monthly on the 15th by
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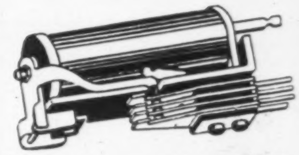

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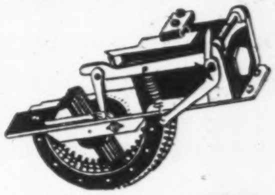

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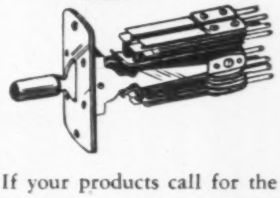

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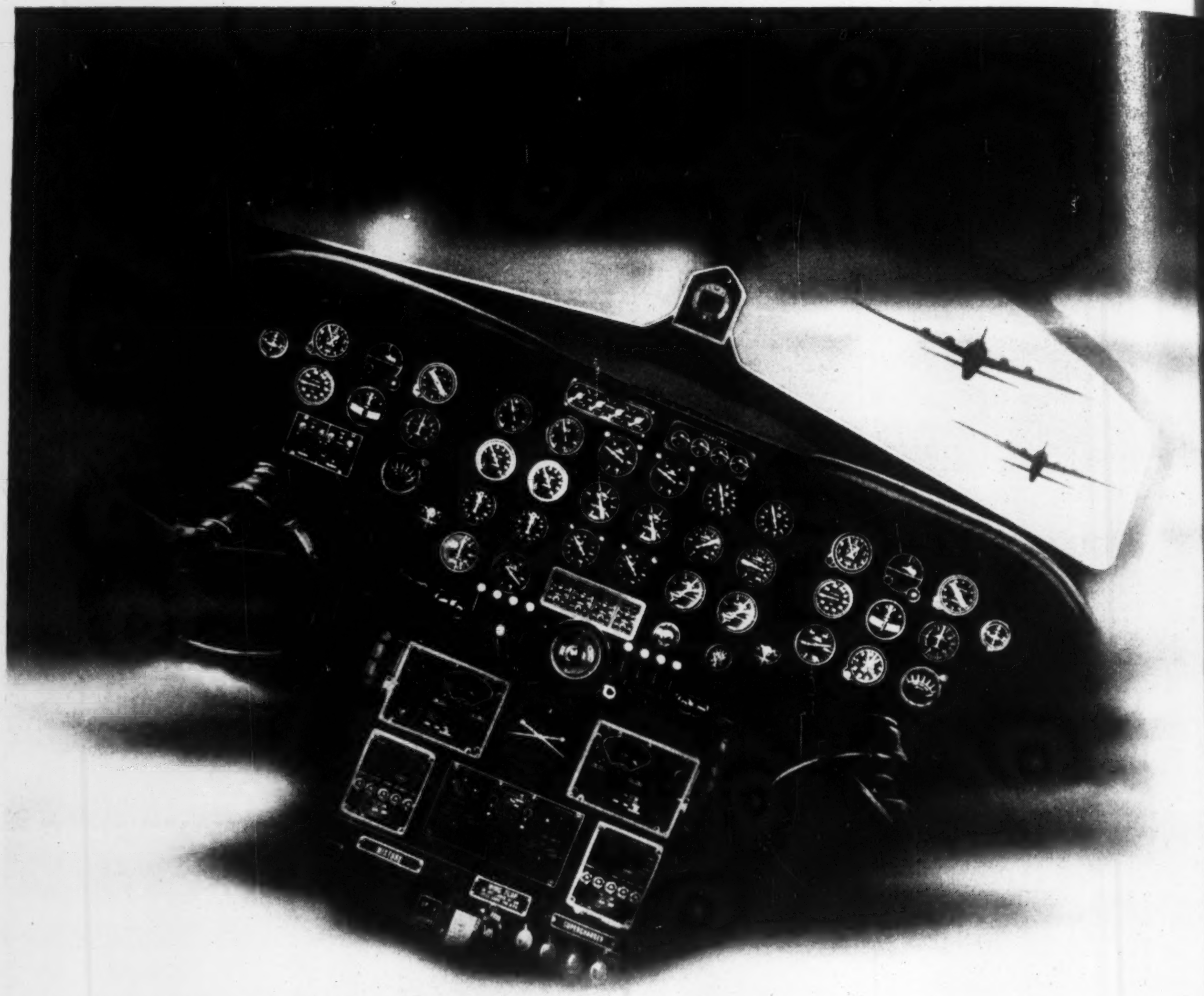

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The 1944 Instruments Index

THIS issue of the INDEX has been compiled to meet the need of users of instruments and devices for measurement, inspection, testing and control, for a purchasing directory of such equipment. Since the 1943 INDEX, 150 companies' names and products, which have not appeared previously, were included. The INDEX contains the answers to 99% of the inquiries which *Instruments* receives from subscribers, and places at your instant command a wealth of information.

This directory is arranged, indexed and cross-indexed to make its contents easily available.

The Index Section—"Who makes what"—is the most important. Anyone who wants to know where he can buy or secure information on a certain product will find the product properly indexed and cross-indexed, and under it the names of the manufacturers of this equipment and manufacturers' sole representatives.

Many products listed are on a priority basis, other items are available only to military customers at present, but manufacturers will be glad to receive inquiries from you on the possibility of being able to supply your needs in spite of priorities.

Indexing System. Products are indexed under the main word. In cases where a name is ambiguous, or where the item is known under two or more names, companies making such devices are listed under one heading and cross-references inserted under the other headings.

Specific Terms. You never are in need of "a gage" but of some particular kind of gage. Therefore we do not list manufacturers under broad general designations. For example, we do not list any names under the main heading "Meters" but we give the sources of supply for numerous classes and types of meters. Moreover, we do not list any names under "Meters, Liquid" alone, but we give under proper subheads the sources of supply for the *class* and *type* of liquid meter you may need.

Correctness of Headings. As explained above, main headings and subheads are technically correct. A few are not scientifically correct: they are names in common usage, recognized for the convenience of the majority.

Correctness of Listings. A few of the companies listed and advertising in the INDEX you already know. All of them are actively engaged in the manufacture of instruments and devices for measurement, inspection, testing and control. We have endeavored to list no firm names under specific headings unless the instruments made by such firms belong there by virtue of their design and construction. As a rule, we have to take the company's word that it could supply the product in question.

Completeness. More than 1200 manufacturers were canvassed in the last four months. In the last few weeks we sent representatives to call on manufacturers. Therefore, the omission of any manufacturer's name under any heading is due to the negligence of someone in his own organization.

Every effort has been made to restrict the names in the Index Section to (1) the actual manufacturers and (2) the sole authorized sales agencies. On the other hand, whenever you desire to order at one time a variety of equipment, made by different firms, you may find it most convenient to get in touch with a recognized, competent, "laboratory supply house." These houses are listed under "*Apparatus, Laboratory,*" on page 14.

Instruments' Further Service. This Index contains the answers to *only* 99% of your inquiries. If you cannot find the product or the name you want, communicate with the Information Section, Instruments Publishing Co., 1117 Wolfendale St., Pittsburgh 12, and every effort will be made to furnish the information promptly.

Suggestions. We shall appreciate suggestions regarding:

1. Headings not at present found in this Index which should be there,
2. Firms listed erroneously, and
3. Other inaccuracies which may have crept in despite all precautions.

Use this INDEX consistently. You will find the companies listed herein equipped to render the kind of service which saves time and helps make satisfied customers.

Where companies in whose products you are interested have omitted descriptions, your cooperation is invited in bringing this to the attention of the supplier or the publisher. Also, whenever the INDEX has aided you, please inform the manufacturer that his data in THE INSTRUMENTS INDEX were of help to you.

For announcement Special New Service see either page 97 or page 139.

INDEX SECTION

ABRASION MACHINES (See Testers, Abrasion)

ABSOLUTE PRESSURE INDICATORS (See Gages, Absolute Pressure)

ABSORPTIOMETERS
Brabender Corp.
Jarrel-Ash

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Kollsman Inst. Co.
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Pioneer Instrument
RCA Manufacturing Co.
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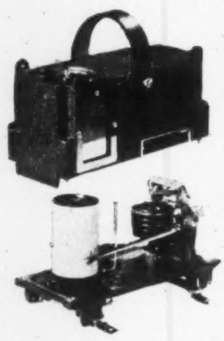

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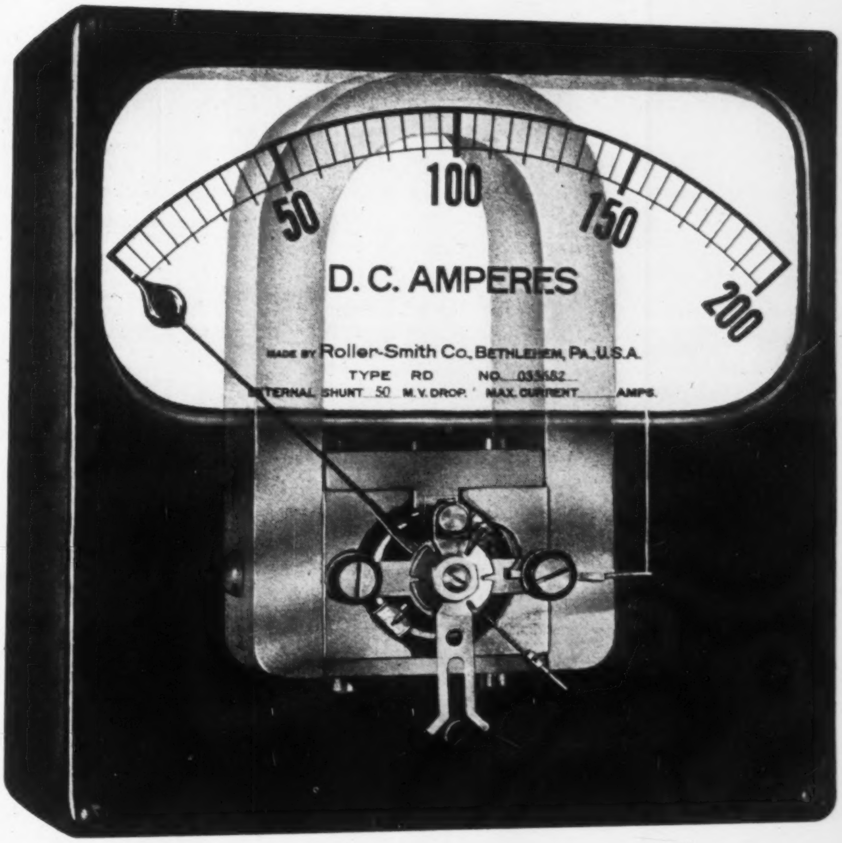
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- Consolidated Engg.
- Dayton Acme Co.
- Electronic Design Corp.
- Electronic Lab.
- General Radio Co.
- Heiland Research Corp.
- McFarlin Co.
- Metron Instrument
- Rauland Corp.
- Raytheon Mfg. Co.
- RCA Manufacturing Co.
- Sun Radio Co.
- Thordarson Elec. Co.
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- United Cinephone Corp.
- United Transformer
- Waugh Labs.

AMPLIFIERS, Audio Frequency (See Audio-Frequency Equipment)

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- McFarlin Co.
- Metron Instrument
- Raytheon Mfg. Co.
- Televiso Co.
- United Cinephone Corp.
- United Transformer Corp.

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- Amplifier Co.
- Electro-Medical Lab.
- Electronic Design Corp.
- Electronic Lab.
- General Elec. Co.
- General Radio Co.
- McFarlin Co.
- Metron Instrument
- Raytheon Mfg. Co.
- Rowe Radio Research

AMPLIFIERS, Radio Frequency
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- Geophysical Inst. Co.
- Heiland Research
- Hollywood Electronics
- McFarlin Co
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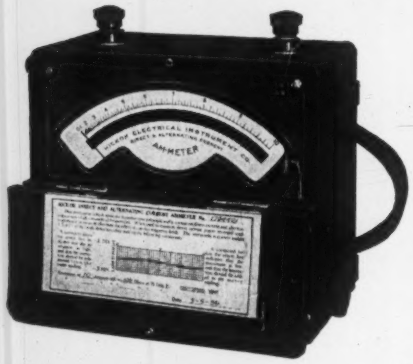

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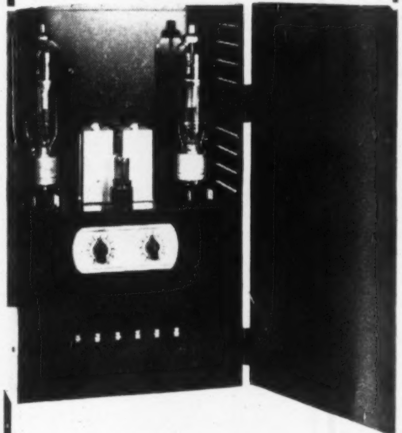

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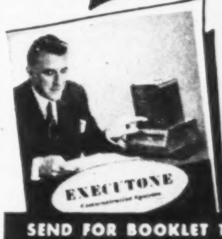

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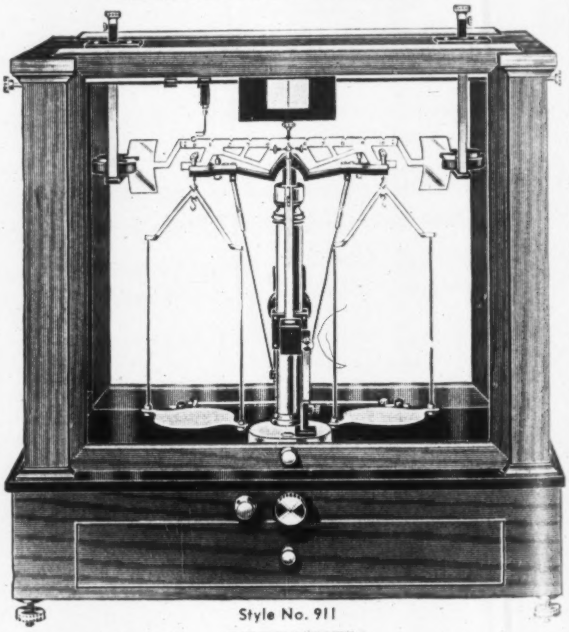

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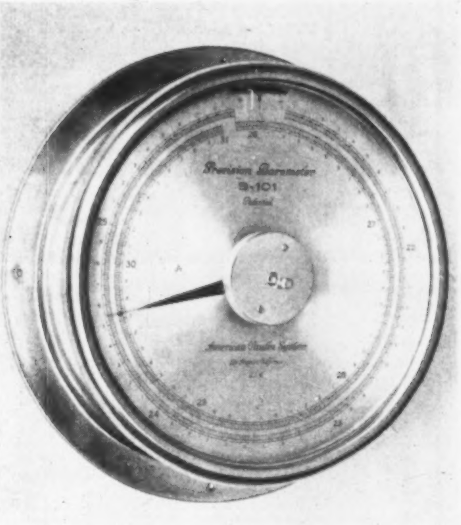

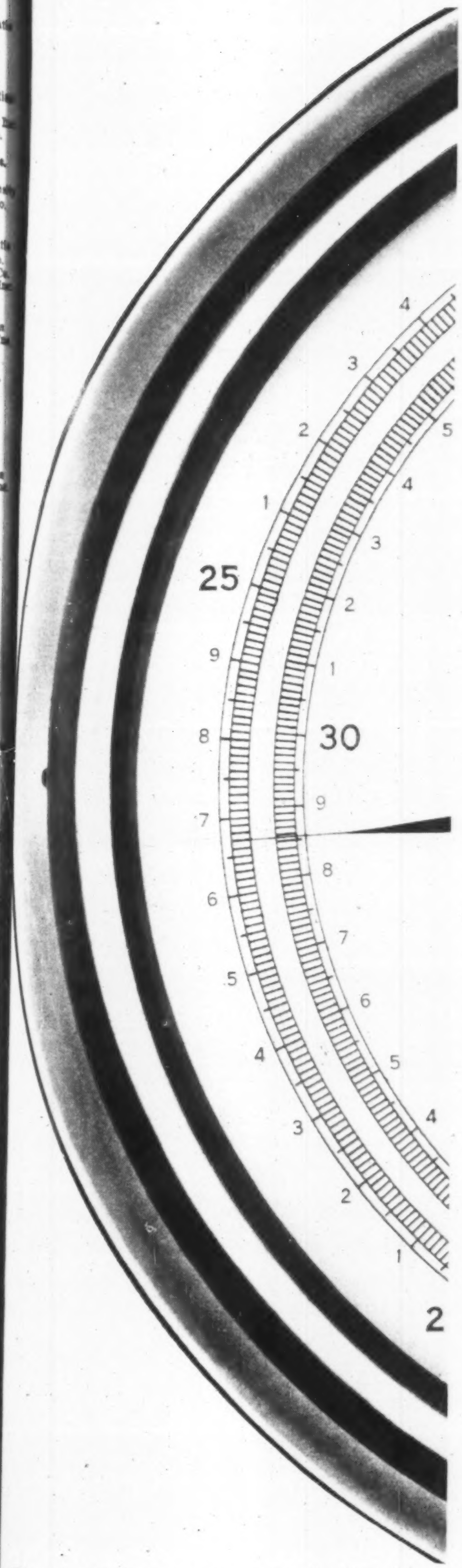

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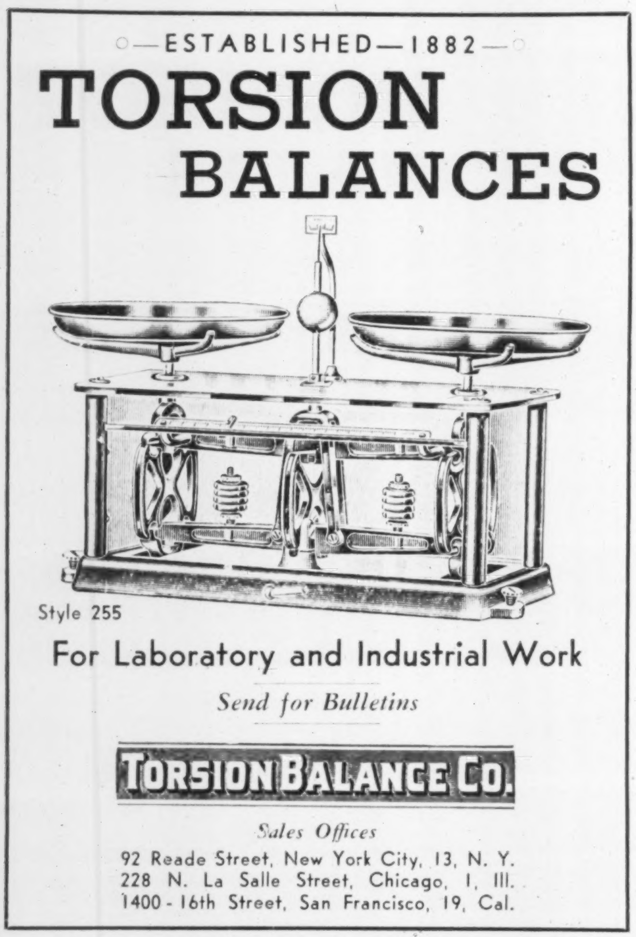

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Voland & Sons, Inc.
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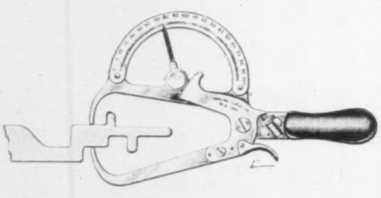

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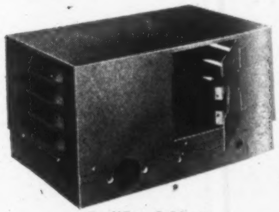

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Hamilton Watch
Meridian-Instrument
Negus, T. S. & J. D.
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Cincinnati Clock & Inst.

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International Bus. Mach.
National Time & Signal
Paragon Electric Co.
Standard Elec. Time
Stromberg Electric Co.
Thomas Clock Co.
Waltham Watch
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Cincinnati Time Rec. Co.
Cramer & Co., Inc.
Elec. Tachometer Corp.
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International Bus. Mach.
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General Elec. Co.
Howard Clock Products
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Howard Clock Products
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Stromberg Electric Co.
Thomas Clock Co.
Warren Telechron

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Jaeger Watch Co.
Kollsman Inst. Co.
Standard Elec. Time
Waltham Watch
Warren Telechron

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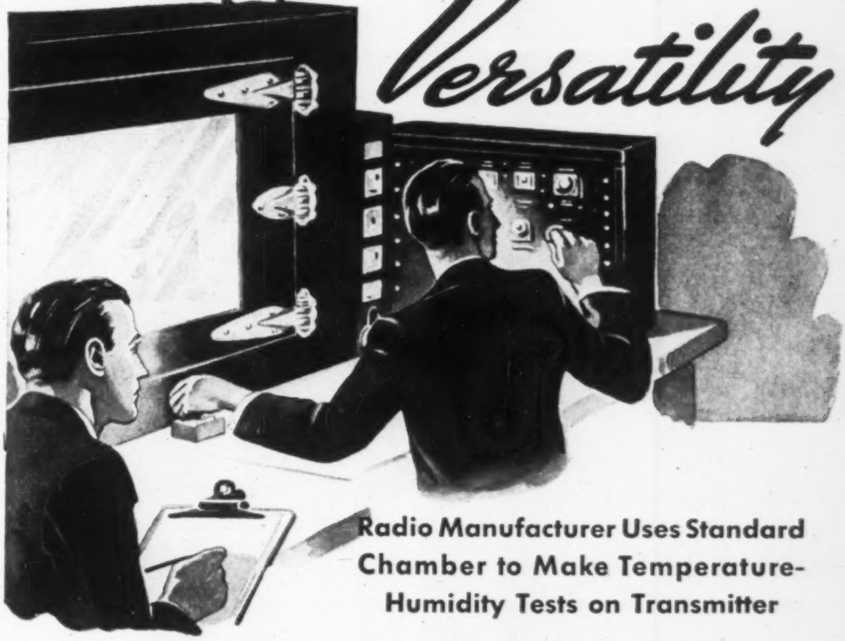

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D From –85° F. to –95° F., with 500 watts being dissipated. Time 30 minutes.

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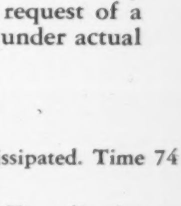

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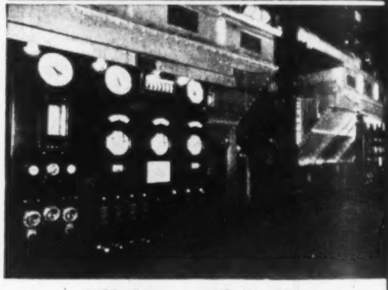

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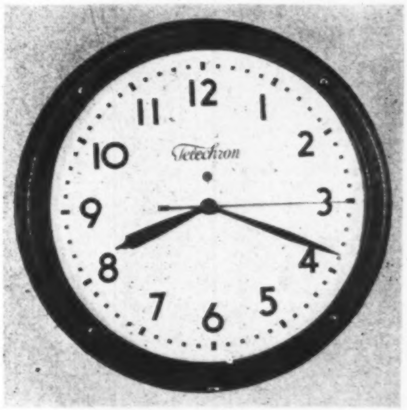

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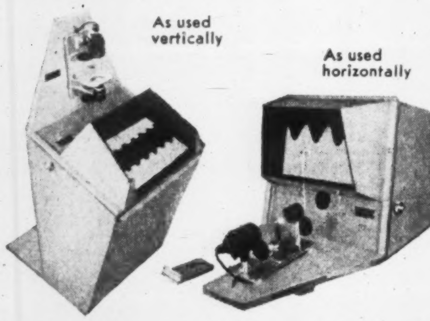

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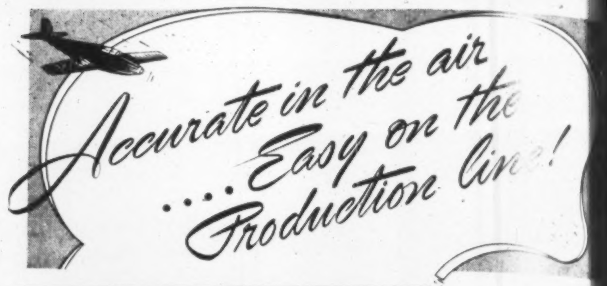
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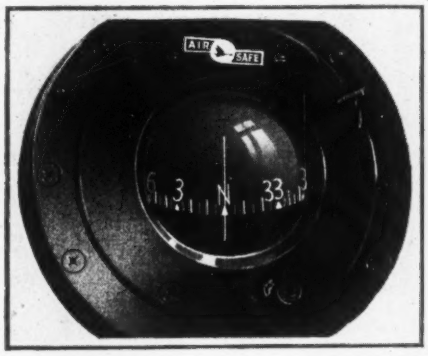

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CONTROLS, AUTOMAT (See Controllers, Au matic)

CONTROLLERS, AUTO MATIC (See also s ject of Measurem and Control)

"CONTROL" — NOTE —

The following pages d **serve close study.** Note f **example that** after nume **ous "Controllers,** Autom **tic" there are** three class **of "Controllers,** Manual. **Look up also** under "Reg **lators" for many** types th **termed by** usage. A **"Thermostats"** and oth **commonly-used** names **specific-purpose** automat **controllers.**

As a rule, Automat **Controllers are** "Instrumen **like" while** devices know **as Controls** (preceded **name of** applicat n) a **simple, single-pur** d **vices.**

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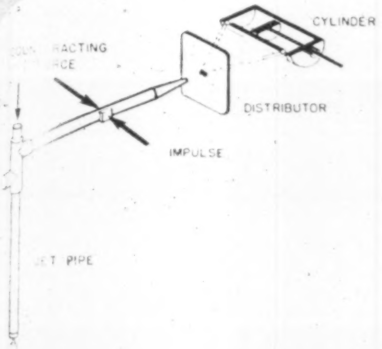

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Combustion control

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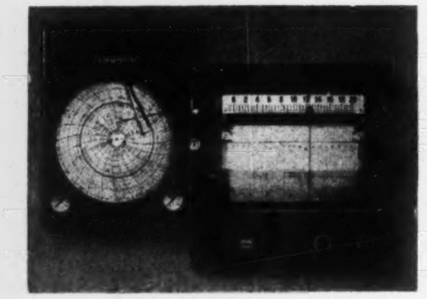

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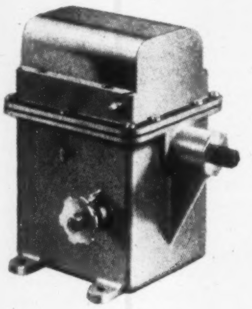

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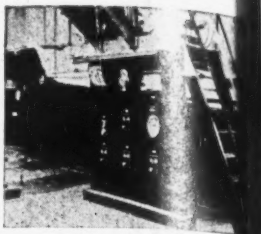

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CONTROLLERS, AUTOMATIC, Beater (See Controllers, Automatic, Consistency)

CONTROLLERS, AUTOMATIC, Bin (see Controllers, Automatic, Granular Material, Level)

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Combustion Control Corp.
Fisher Governor
Fischer & Porter
Foster Engg. Co.
Foxboro Co.
Henszey Co.
Kiely & Mueller
Leeds & Northrup
Manning, Maxwell&Moore
Mason-Neilan Regulator
McAlear Mfg.
McDonnell & Miller
Mercon Regulator Co.
Natural Gas Equipment
Northern Equip. Co.
Republic Flow Meters Co.
Robertshaw Thermostat
Ruggles-Klingemann
Watts Regulator Co.
Wheelco Instruments
Wilgus Mfg. Co.

CONTROLLERS, AUTOMATIC, Boiler Water Concentration
Cochrane Corp.
Fischer & Porter
Henszey Co.
Leeds & Northrup Co.
Republic Flow Meters
Manning, Maxwell&Moore

CONTROLLERS, AUTOMATIC, Bulk Material Level see Controllers, Automatic, Granular Material Level

CONTROLLERS, AUTOMATIC, Chlorine
Arca Regulators, Inc.
Askania Regulator Co.
Builders-Providence
Everson Mfg. Co.
Fischer & Porter
LaMotte Chemical Prod.
Manning, Maxwell&Moore
National Meter Co.
Rascher & Betzold
Victor Equipment Co.
Wallace & Tiernan

CONTROLLERS, AUTOMATIC, Combustion
Anderson Co.
Arca Regulators, Inc.
Askania Regulator Co.
Bailey Meter Co.
Brooke Eng. Co.
Cambridge Inst. Co.
Cash Co.
(Cont'd)

CONTROLLERS, AUTOMATIC, Combustion (Cont'd)
Combustion Control Corp.
Consulting & Engineering
Denver Fire Clay Co.
General Combustion Corp.
General Regulator Corp.
Hagan Corp.
Hays Corp.
Lantz-Phelps Corp.
Leeds & Northrup Co.
Mason-Neilan Reg. Co.
Minneapolis-Honeywell
National Airoil Burner
National Brass Co.
Natural Gas Equipment
Republic Flow Meters
Selas Company
Worner Products

CONTROLLERS, AUTOMATIC, Condensation
Bailey Meter Co.
Boylston Co.
Fisher Governor Co.
Friez & Sons
General Regulator Corp.
Manning, Maxwell&Moore
Photoswitch, Inc.
Seely Instrument Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.

CONTROLLERS, AUTOMATIC, Condenser Leakage
Leeds & Northrup Co.
Manning, Maxwell&Moore

CONTROLLERS, AUTOMATIC, Consistency
Brabender Corp.
Bristol Co.
D'Este Co.
Foxboro Co.
Mason-Neilan Regulator
McAlear Mfg.
Merritt Engr. & Sales
Paprex Co
Process Controls, Inc.

CONTROLLERS, AUTOMATIC, Counting
Abrams Instrument
Bristol Co.
Eagle Signal Corp.
Lumenite Electric Co.
Manning, Maxwell&Moore
National Time & Signal
Photoswitch, Inc.
Seely Instrument Co.
Standard Electric Time
United Cinephone Corp.

CONTROLLERS, AUTOMATIC, Current (See Regulators)

CONTROLLERS, AUTOMATIC, Cycle
Abrams Instrument
Autocall Co.
Bailey Meter Co.
Barber Coleman
Betts & Betts
Bristol Co.
Brown Inst. Co.
(Cont'd)

CONTROLLERS, AUTOMATIC, Cycle (Cont'd)
Cramer & Co., Inc.
Denver Fire Clay Co.
Elec. Switch Corp.
Fisher Governor
Foxboro Co.
Hagan Corp.
Hanlon-Waters, Inc.
Industrial Timer Corp.
Leeds & Northrup Co.
Manning, Maxwell&Moore
Mason-Neilan Reg. Co.
Minneapolis-Honeywell
Monitor Controller Co.
National Time & Signal
Seely Instrument Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.

CONTROLLERS, AUTOMATIC, Damper
A-Jacks Automatic
Arca Regulators, Inc.
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Barber-Coleman Co.
Belfield Co.
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
Cash Co.
Cook Electric Co.
Davis Reg. Co.
(Cont'd)

CONTROLLERS, AUTOMATIC, Damper (Cont'd)
Denver Fire Clay Co.
Electronic Prod. Co.
Fisher Governor
Foster Eng. Co.
Foxboro Corp.
Friez & Sons, Julien
Gleason-Avery, Inc.
Hagan Corp.
Hanlon-Waters, Inc.
Hays Corp.
Johnson Service Co.
Kiely & Mueller
Leeds & Northrup Co.
Mason-Neilan Regulator
Manning, Maxwell&Moore
Minneapolis-Honeywell
National Airoil Burner
Natural Gas Equipment
Penn Electric Switch Co
Powers Regulator Co.
Preferred Utilities Mfg.
Republic Flow Meters
Ruggles-Klingemann
Echade Valve Mfg. Co.
Spence Eng. Co., Inc.
Tagliabue Mfg. Co.
Taylor Instrument Cos.
Watts Regulator Co.
White-Rodgers Electric
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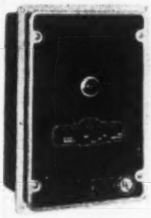
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

Wheelco Flame-otrols Combustion Safeguards



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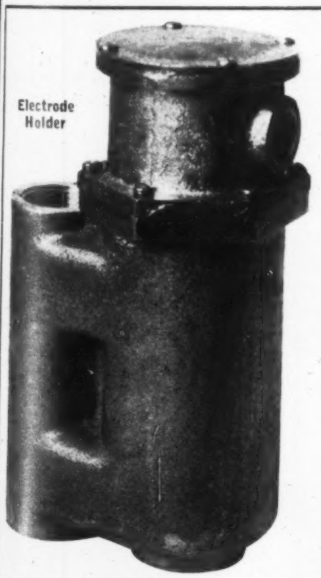

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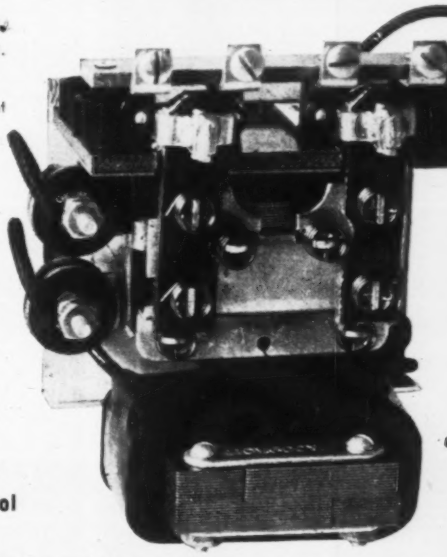

CONTROLLERS, AUTOMATIC, Density

Acme Regulator Co.
Arca Regulators, Inc.
Automatic Valve Control.
Lumenite Electric Co.
Manning, Maxwell&Moore
Mine & Smelter Supply
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.

CONTROLLERS, AUTOMATIC, Desuperheat

Arca Regulators, Inc.
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Foxboro Corp.
Hagan Corp.
Leeds & Northrup Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
Mercon Regulator Co.
Northern Equip. Co.
Republic Flow Meters Co.
Spence Eng. Co., Inc.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trerice Co.

CONTROLLERS, AUTOMATIC, Draft

A-Jacks Automatic
Arca Regulators, Inc.
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Barber-Coleman Co.
Boiler Room Equip.
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
Cash Co.
Denver Fire Clay Co.
Foster Eng. Co.
Foxboro Co.
Friez & Sons, Julien
General Regulator Corp.
Gleason-Avery, Inc.
Hagan Corp.
Hays Corp.
Leeds & Northrup Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
Minneapolis-Honeywell
National Airoil Burner
National Brass Co.
Preferred Utilities Mfg.
Republic Flow Meters
Ruggles-Klingemann
Tagliabue Mfg. Co.
Taylor Inst. Cos.

CONTROLLERS, AUTOMATIC, Feed Water

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Atlas Valve Co.
Bailey Meter Co.
Belfield Co.
Fisher Governor
Fischer & Porter
Hagan Corp.
Hanlon-Waters, Inc.
Henszey Co.
Kiely & Mueller
Manning, Maxwell&Moore
Mason-Neilan Reg. Co.
McAlear Mfg. Co.
McDonnell & Miller
Mercon Regulator Co.
Natural Gas Equipment
Northern Equip. Co.
Republic Flow Meters
Ruggles-Klingemann
Schade Valve Mfg. Co.
Simplex Valve & Meter
Watts Regulator Co.
Wheelco Instruments
Wilgus Mfg. Co.

CONTROLLERS, AUTOMATIC, Filter Rate

Builders-Providence
Cochrane Corp.
Fischer & Porter
Infilco, Inc.
Manning, Maxwell&Moore
Mason-Neilan Reg. Co.
Taylor Inst. Cos.

CONTROLLERS, AUTOMATIC, Float

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Autocall Co.
Automatic Control Co.
Automatic Temp. Control
Bailey Meter Co.
Belfield Co.
Builders-Providence
Cash Co.
Cochrane Corp.
Cutler-Hammer, Inc.
Davis Regulator Co.
Fisher Governor
Furnas Electric Co.
Foster Engg. Co.
Foxboro Co.
Frick Co.
Hagan Corp.
Hanlon-Waters, Inc.
Kiely & Mueller
Leupold & Stevens
Mason-Neilan Regulator

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McAlear Mfg. Co.
Mercon Regulator Co.
Northern Equipment
Penn Electric Switch
Powers Regulator Co.
Ruggles-Klingemann
Schade Valve Mfg. Co.
Simplex Valve & Meter
Spence Eng. Co., Inc.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Water Level Controls Co.

CONTROLLERS, AUTOMATIC, Flow

Adel Precision
American Meter Co.
Arca Regulators, Inc.
Askania Regulator
Bailey Meter Co.
Bristol Co.
Brooke Engineering
Brown Inst. Co.
Builders-Providence
Cash Co.
Denver Fire Clay Co.
Electrimatic Corp.
Fischer & Porter
Foster Engg. Co.
Foxboro Co.
General Regulator Corp.
Hagan Corp.
Hanlon-Waters, Inc.
Infilco, Inc.
Leeds & Northrup Co.
Leupold & Stevens
Mason-Neilan Regulator
McAlear Mfg. Co.
Mercon Regulator Co.
Northern Equipment
Process Controls, Inc.
Republic Flow Meters
Simplex Valve & Meter
Spence Eng. Co., Inc.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Victor Equipment Co.
Wheelco Instruments
Wilgus Mfg. Co.

CONTROLLERS, AUT MATIC, Flow Prop tioning

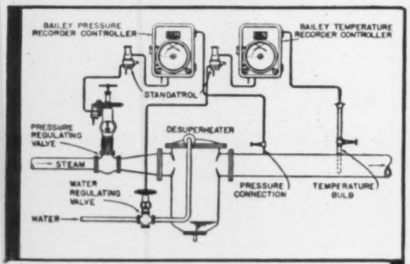
American Meter Co.
Arca Regulators, Inc.
Askania Regulator Co.
Autocall Co.
Automatic Temp. Contr
Bailey Meter Co.
Barber-Coleman Co.
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
Builders-Providence
Cash Co.
Cochrane Corp.
Cutler-Hammer, Inc.
Electronic [illegible] Co.
Fischer & Porter
Foxboro Co.
General Regulator Cor
Hagan Corp.
Hanlon-Waters, Inc.
Henszey Co.
Illinois Engr. Co.
Infilco, Inc.
Lammert & Mann Co.
Mason-Neilan Regulato
McAlear Mfg. Co.
Mercon Regulator Co.
Republic Flow Meters Co
Reynolds Gas Regulato
Simplex Valve & Meter
Spence Engr. Co., Inc.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Vergillo Co.
Victor Equipment Co.
Wheelco Inst. Co.

CONTROLLERS, AUTOMATIC, Fluid Propor- tioning

(See Controllers, Automatic, Flow Proportioning)

CONTROLLERS, AUTOMATIC, Frequency

(See Regulators)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BAILEY TEMPERATURE RECORDER CONTROLLER
STANDATROL
PRESSURE REGULATING VALVE
DESUPERHEATER
STEAM
WATER REGULATING VALVE
WATER
PRESSURE CONNECTION
TEMPERATURE BULB

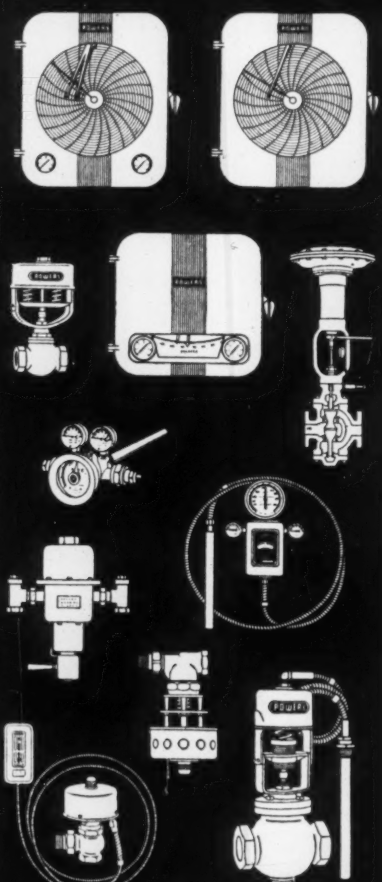
DESUPERHEATING & PRESSURE REDUCING CONTROL

● Bailey Meter Control of desuperheating and pressure reducing incorporates standard Bailey Recorder-Controllers for both pressure and temperature, as well as a special Bailey Reducing Valve equipped with valve positioner and air cooled packing gland.

The control system is air-operated and is arranged to maintain the desired final steam temperature by controlling the quantity of water fed to a cartridge type desuperheater. This temperature is measured by a sensitive bare bulb temperature recorder-controller with the temperature bulb located at the ● outlet of the desuperheater.

BAILEY METER COMPANY
1041 IVANHOE ROAD · CLEVELAND, O.
Bailey Meter Company Ltd., Montreal, Canada

POWERS
TEMPERATURE and HUMIDITY
CONTROL



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THE POWERS REGULATOR CO.

Bailey FEED WATER Control

● Bailey Meter Company offers three distinct feed water control systems. They are (1) the Thermo-hydraulic Feed Water Regulator which is suitable for the majority of small boilers operating at relatively low pressures. This regulator operates from water level alone and is provided with a fully balanced tight seating V-port regulating valve designed to give a straight line characteristic. It offers the advantages of low installation cost, removable valve parts and independence of valve location.

(2) The Single-Element air-operated feed water control system is recommended for installations on which smooth regulation of feed water flow is desired, and a wide regulating range cannot be used. This system is controlled by water level alone as measured by a Bailey Boiler Drum Water Level Recorder.

(3) Bailey Three-Element feed water control is recommended for high capacity low water storage boilers operating at high pressures or for boilers operating at medium pressures with violent load fluctuations. This system is based on actual measurement of water flow to the boiler, steam flow from the boiler and water level within the boiler, and is adjusted primarily to control the rate of water flow to the boiler so that it equals the rate of steam flow from the boiler.

For detailed information consult Sweet's Engineering Catalogs or request bulletin ● No. 105-A.

BAILEY METER COMPANY
1041 IVANHOE ROAD · CLEVELAND, O.
Bailey Meter Company Ltd., Montreal, Canada

CONTROLLERS, AUTOMATIC, Furnace

A-Jacks Automatic
Am Gas Furnace Co.
Arca Regulators, Inc.
Askania **Regulator Co.**
Automatic **Elec. Mfg. Co.**
Automatic **Temp. Control**
Bailey **Meter Co.**
Barber-Colman **Co.**
Bristol Co.
Brooke Eng. **Co.**
Brown Inst. **Co.**
Cash Co.
Cook Electric Co.
Defender Automatic Reg.
Denver Fire **Clay Co.**
Dickson Co.
Friez & **Sons**
Fulton Sylphon **Co.**
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Gleason-Avery, Inc.
Hagan Corp.
Hays Corp.
Industrial Engr. Corp.
Johnston Mfg. Co.
Leeds & **Northrup**
Lindberg Eng. Co.
Manning, Maxwell&Moore
Marsh Corp.
Mason-Neilan Regulator
McCorkle Co.
Minneapolis-Honeywell
National Airoil Burner
National Brass Co.
Natural Gas Equipment
Paragon Electric Co.
Partlow Corp.
Payne Furnace & Supply
Penn Electric Switch
Perfex Corp.
Pyrometer **Inst. Co.**
Republic Flow Meters
Ruggles-Klingemann
Spence Engineering Co.
Spencer Thermostat Co.
Tagliabue **Mfg. Co.**
Taylor **Inst. Cos.**
United Cinephone Corp.
Wheelco **Inst. Co.**
White Mfg. Co.
White-Rodgers Electric
Wilgus Mfg. Co.

CONTROLLERS, AUTOMATIC, Gas Density

Refinery **Supply Co.**

CONTROLLERS, AUTOMATIC, Gas Mixing

(See Controllers, Automatic, Flow Proportioning)

CONTROLLERS, AUTOMATIC, Granular Material Level

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Mosher Electronic
Photoswitch, Inc.
Stephens-Adamson
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CONTROLLERS, AUTOMATIC, Granular Material, Weight

Omega Machine

CONTROLLERS, AUTOMATIC, Gravity

Arca Regulators, Inc.
Askania Regulator Co.
Bailey Meter Co.
Ess Instrument
Foxboro Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
Mine & Smelter Supply
Moore Products
Tagliabue Mfg. Co.
Taylor Inst. Cos.

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Arca Regulators, Inc.
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Barber-Coleman Co.
Brabender Corp.
Bristol Co.
Brown Inst. Co.
Cramer & Co., Inc.
Dietert Co.
Electronic Prod. Co
Fenwal, Inc.
Foxboro Co.
Friez & Sons
General Controls Co.
H-B Inst. Co., Inc.
Johnson Service Co.
Leeds & Northrup Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
McDonnell & Miller
Minneapolis-Honeywell
Moeller Instrument Co.
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CONTROLLERS, AUTOMATIC, Humidity (Cont'd)

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Parks-Cramer Co.
Penn Electric Switch
Phila. Thermometer Co.
Powers Regulator Co.
Robertshaw Thermostat
Sarco Co., Inc.
Scientific Inst. Co.
Seely Instrument Co.
Supreme Elec. Prods.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Thwing-Albert Inst. Co.
Trerice Co., H. O.
Valverde Labs.
Vaughn G. F. Witt Co.
Weksler Thermometer

CONTROLLERS, AUTOMATIC, Humidity and Temperature (See Controllers, Automatic, Humidity and Controllers, Automatic, Temperature)

CONTROLLERS, AUTOMATIC, Lighting

Abrams Instrument
Betts & Betts
Cutler-Hammer, Inc.
Paragon Electric Co.
Photoswitch, Inc.
United Cinephone Corp.
Weston Elec. Inst. Corp.
Zenith Electric Co.

CONTROLLERS, AUTOMATIC, Liquid Level

Allen-Bradley Co.
American Meter Co.
Arca Regulators, Inc.
Askania Regulator Co.
Atlas Valve Co.
Autocall Co.
Automatic Control Co.
Automatic Temp. Control
Bailey Meter Co.
Barber-Colman
Bastian-Blessing Co.
Belfield Co.
Bin-Dicator Co.
Boylston Co.
Bristol Co.
Brown Inst. Co.
Builders-Providence
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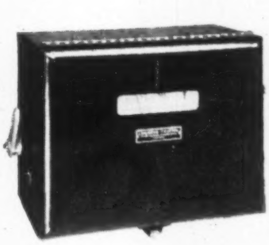

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STRAIGHT LINE CONTROL

When it's performance you want, Lindberg "Straight Line Control" is always ready to provide precision controlled heat input. Overheating and underheating are eliminated. Built to do the job accurately and trouble free.

● Write for illustrated literature covering *Lindberg Throttling Control* for gas or oil fired furnaces and *Lindberg Input Control* for electrically heated equipment.

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2466 West Hubbard Street • Chicago 12, Ill.

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Automatic Control Equipment

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For EVERY Control Problem

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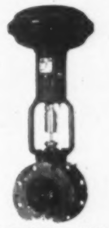
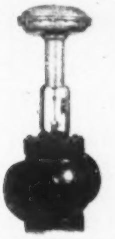


6" FG Type 1500 BUTTERFLY VALVE

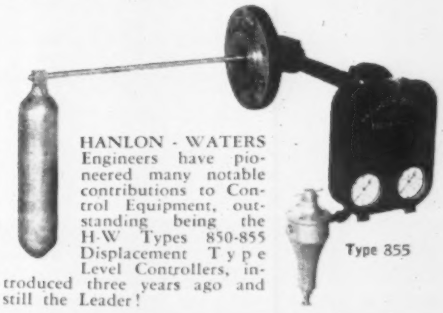
1" SG Type 15-DRT MOTOR VALVE

Type 86-F MOTOR VALVE



8" Std. FG Type 86 MOTOR VALVE

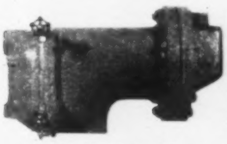
2" Std. Type 97-RF Duplex Diaphragm Regulator



HANLON - WATERS Engineers have pioneered many notable contributions to Control Equipment, outstanding being the H-W Types 850-855 Displacement Type Level Controllers, introduced three years ago and still the Leader!

Type 855

NO STUFFING BOX . . . . LEAKAGE . . . . . . FRICTION



8" Type 140 Vent Trap

8" Type 90 Continuous Drainer

H-W Equipment is available for use in recycling, Gasoline Plants, Refineries, Chemical, Synthetic and Power Plants, and are the answer to control problems in many Industries, to meet all pressure regulation, flow or level control requirements.

SG Type 170 Safety Manual Reset Regulator

3/4" SG Type 270 Reducing Regulator

ASK THE MEN WHO OPERATE THEM

Information on all HANLON-WATERS Equipment is available at representative nearest you.

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TULSA, OKLAHOMA
NEW YORK, CHICAGO, PITTSBURGH, PHILADELPHIA, BOSTON, CINCINNATI, ST. LOUIS, KANSAS CITY, DENVER, LOS ANGELES, MOBILE, SHREVEPORT, LA., FT. WORTH, HOUSTON, CORPUS CHRISTI, AMARILLO AND ODESSA, TEXAS.

Count Anything from SHADOWS to BOXCARS

Wizard Electric Counters count anything that will operate a switch, relay or photo-electric cell. They are being operated by the sound of falling parts. May be located at any distance from the source of count.

Every part of Wizard Counters is designed for electrical operation in heavy duty industrial service. Current draw is only 4 watts. Operates to 600 counts per minute. Has continuous duty coils. All working parts enclosed.

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Production Instrument Company
702 W. JACKSON BLVD. CHICAGO 6, ILL.
Manufacturers of Counting, Timing and Recording Devices

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Cochrane Corp.
Control Corp.
Cutler-Hammer, Inc.
Davis Reg. Co.
Defender Automatic Reg.
Electronic Prod. Co.
D'Este Co.
Elec. Indicator Co.
Fisher Governor Co.
Foster Engg. Co.
Foxboro Co.
Frick Co.
Julien P. Friez & Sons
Fuller Co.
General Controls Co.
General Electric Co.
General Regulato. Corp.
Guardian Elec. Mfg. Co.
Hagan Corp.
Hanlon-Waters, Inc.
Inferno Co.
Infilco, Inc.
Johnson Service Co.
Kiely & Mueller
Klipfel Mfg. Co.
Leeds & Northrup Co.
Leupold & Stevens
Lumenite Elec. Co.
Manning, Maxwell&Moore
Mason-Neilan Regulator
McAlear Mfg. Co.
McDonnell & Miller
Mercoid Corp.
Mercon Regulator Co.
Minneapolis-Honeywell
Moore Products Co.
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Northern Equip. Co.
Paragon Electric Co.
Penn Electric Switch
Petrometer Corp.
Photoswitch, Inc.
Powers Regulators Co.
Precision Therm.
Reliance Gauge Column
Republic Flow Meters
Rowan Controller Co.
Ruggles-Klingemann
Schade Valve Mfg. Co.
Fred H. Schaub Eng.
Simplex Valve & Meter
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Spence Engineering Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
United Cinephone Corp.
Warrick Co., C. F.
Water Levels Controls Co.
Watts Regulator Co.
Wheelco Inst. Co.
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CONTROLLERS, AUTOMATIC, Load (See Regulators)

CONTROLLERS, AUTOMATIC, Moisture (See Controllers, Automatic, Humidity)

CONTROLLERS, AUTOMATIC, pH
Leeds & Northrup

CONTROLLERS, AUTOMATIC, Phase (See Regulators)

CONTROLLERS, AUTOMATIC, Power Factor (See Regulators)

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Askania Regulator Co.
Arca Regulators, Inc.
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Autocall Co.
Automatic Control Co.
Automatic Temp. Control
Bailey Meter Co.
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Cash Co.
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D'Este Co.
Dickson Co.
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Ford Reg. Valve Co.
Foster Engg. Co.
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Lindberg Eng. Co.
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Mason-Neilan Regulat
Partlow Corp.
Pyrometer Instrument C
Seely Instrument Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Thwing-Albert Instrum
Uehling Instrument C
Wheelco Inst. Co.

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Am. Automatic Electr
Guardian Elec. Mfg. C
Metron Instrument
United Cinephone Corp

CONTROLLERS, AUTOMATIC, Rate-Volum (See Controllers, Automatic, Flow)

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Dickson Co.
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Friez & Sons, Julien
Fulton Sylphon Co.
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Illinois Engr. Co.
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McAlear Mfg. Co.
Mercoid Corp
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Taylor Inst. Cos.
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CONTROLLERS, AUTOMATIC, RKVA (See Regulators)

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Baldwin-Southwark Corp

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Foxboro Co.
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Mason-Neilan Regulator
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Republic Flow Meters

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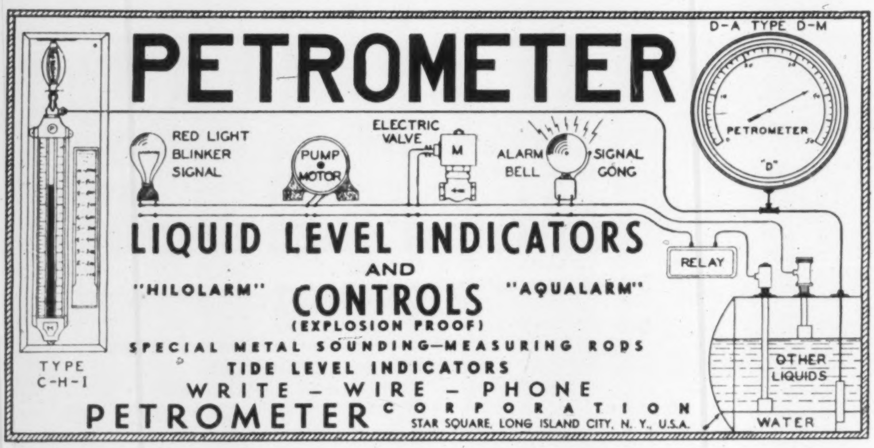
CONTROLLERS, AUTOMATIC, Temperature-Time (See Controllers, Automatic Thermometric; Controllers, Automatic, Thermostatic; Controllers, Automatic, Time)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Barber Coleman
Betts & Betts
Bristol Co.
Brown Inst. Co.
Clare & Co.
Controls, Inc.
Cramer & Co., Inc.
Eagle Signal Corp.
Edison Electrical Prods.
Elec. Switch Corp.
Fisher Governor
Foxboro Co.

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Northwestern Clock Co.
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Penn Electric Switch
Perfex Corp.
Photoswitch, Inc.
Photovolt Corp.
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Seely Instrument Co.
Stromberg Electric Co.
Struthers-Dunn
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Tork Clock Co.
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Wadsworth Elec. Mfg.
Walser Automatic Timer
Ward Leonard
Warren Telechron
Zenith Electric Co.

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Paprex Co.
Scientific Inst. Co.
United Cinephone Corp.

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National Elec. Controller
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Hydraulic Controls

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General Elec. Co.
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National Elec. Controller
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Superior Electric Co.
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Rubicon Co.
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Westinghouse Elec. & Mfg.

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Sargent & Co.
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Thomas Co., Arthur H.

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Warren Telechron
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Ohmer Register Co.
Saxl Inst. Co.
Southwestern Electronics
Talley-Meter Co.
United Cinephone Corp.
Veeder-Root, Inc.

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Cambridge Inst. Co.
Distillation Products
Geophysical Instrument
Vacutron, Inc.
Welch Mfg. Co.

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General Elec. Co.
Ohmer Register Co.
Paragon Electric Co.
Southwestern Electronics
United Cinephone Corp.
Warren Telechron
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COUNTERS, Lumber
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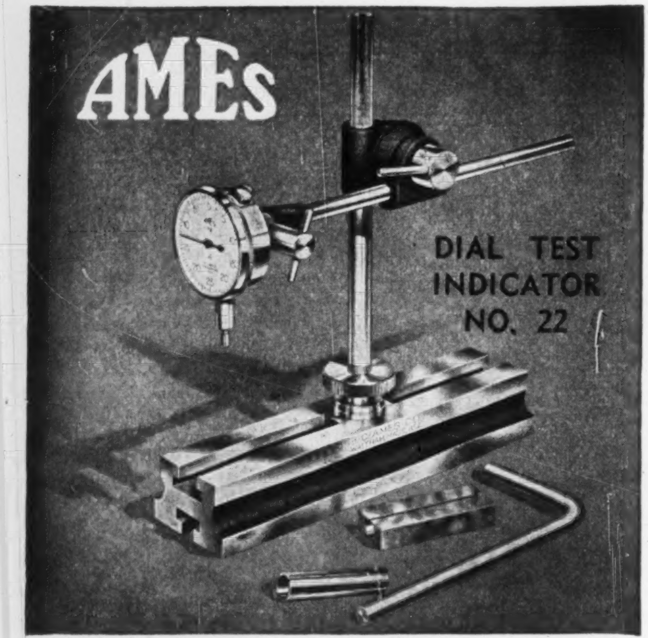

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DETECTORS, Lie
Associated Research
Electro-Medical Labs.

DETECTORS, Mercury Vapor
Mine Safety Appliances

DETECTORS, Metal
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DETECTORS, Mine Gases
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Heiland Research
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DETECTORS, Oxygen Deficiency
Mine Safety Appliances

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Deming Indicator
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Felsenthal & Sons.
General Luminescent

DIFFERENTIAL PRESSURE (See Controllers, Gages, etc., Pressure)

DIFFRACTION GRATING (See Grating, Diffraction)

DILATOMETERS
American Inst. Co.
Bristol Co.
Dietert Co.
Ferner Co.
Gaertner Scientific Corp.
E. Leitz, Inc.
Rockwell Co., Stanley P.
Zeiss, Inc., Carl

DIVIDERS, Voltage (Decade)
Daven Co.
General Radio
Shallcross Mfg.

DIVIDERS, Voltage (Radio Frequency)
Andrew, Victor J.
Beck Bros.
Ferris Inst. Corp.
General Elec. Co.
General Radio Co.
Instrument Resistors, Inc.
International Resistance
Mallory & Co.
Measurements Corp.
Muter Company
Ohmite Mfg. Co.
RCA Manufacturing
Sensitive Research Inst.
Shallcross Mfg. Co.
Televiso Co.
Ward Leonard Elec. Co.

DIVIDING HEAD, OPTICAL
Gaertner Scientific
Zeiss, Inc., Carl

DIVIDING MACHINES
Brown & Sharpe
Gaertner Scientific Corp.
Hayes Scientific Apps.
Mico Instrument Co.
Precise Instrument Co.

DRAFT Indicators (See Gages, Draft) Recorders (See Gages, Draft)

DRAFT Controllers (See Controllers, Automatic Draft)

DRAWING INSTRUMENTS
Alpha Instrument Co.
Altender & Sons
Bruning Co., Inc.
Dietzen Co.
Drafto Co.
Gurley, W. & L. E.
Henschel & Co.
Kern Co.
Keuffel & Esser Co.
Millers Falls Co.
Nelson Section Liner
Post Co., Frederick
Soltmann, Inc., E. G.
Speidel & Co.
Starrett Co., L. S.
Trubene Mfg. Co.
Union Tool Co.
United States Blue Print
Warren-Knight Co.
Weber Co., F.
White Co., Inc., David

DRIFT INDICATORS
Driftmeters, Inc.
Gurley, W. & L. E.
Kollmorgen Optical Co.
Kollsman Inst. Co.
Pioneer Instrument Co.
RCA Manufacturing
Maxwell Smith Co.

DRIFT INDICATORS, Bore Hole
Ruska & Co.
Sperry-Sun Well Surveying

DUROMETERS (See Testers & Testing Machines, Hardness)

DUST ANALYSIS APPARATUS
Bausch & Lomb Optical
Central Scientific Co.
Corning Glass Works
Eimer & Amend
Falstrom Co.
Federal Pneumatic Systems
Fisher Scientific Co.
Mine Safety Appliances
Pfaltz & Bauer, Inc.
Sargent & Co.
Scientific Glass Apparatus
Scientific Inst. Co.
Willson Products, Inc.
Zeiss, Inc., Carl

DYNAMOMETERS, Hydraulic
Baldwin Southwark
Taylor Mfg. Corp.

DYNAMOMETERS, Pull Rod
Baldwin Southwark
Hathaway Inst. Co.
Hayes Scientific Apps.
Martin Decker Corp.
Metron Instrument
Seederer-Kohlbusch, Inc.

DYNAMOMETERS, Rotary Absorption
Bristol Co.
General Elec. Co.
L A B Corp.
Mid-West Dynamometer

DYNAMOMETERS, Hydraulic
Taylor Manufacturing

DYNAMOMETERS, Tension
Baldwin-Southwark Corp.
Boulin Instrument Corp.
Chatillon & Sons
Dillon & Co.
Hathaway Inst. Co.
Metron Instrument
Olsen Testing Machine
Riehle Div.
Seederer-Kohlbusch
Thwing-Albert

DYNAMOMETERS, Transmission
Baldwin Southwark
Hathaway Instrument
Rubicon Co.
Seederer-Kohlbusch

EARTH CURRENT METERS (See Meters, Earth Current)

EARTH RESISTANCE METERS
American Inst. Co.
Amer. Automatic Elec.
Associated Research
Biddle Co., Jas. G.
Geophysical Inst. Co.
Heiland Research
Industrial Insts. Inc.
Rawson Electrical Inst.
Rubicon Co.
Shallcross Mfg.
Sticht & Co.

EBULLIOMETERS
American Inst. Co.
Braun Corp.
Central Scientific Co.
Eimer & Amend
Precision Therm.
Rascher & Betzold
Tagliabue Mfg. Co.

EBULLISCOPE (See Ebulliometers)

ECHELON GRATING (See Grating, Echelon)

ELECTRIC WAVE FILTER SECTIONS
Andrew, Victor J.
Bliley Electric Co.
Clough-Brengle Co.
General Radio Co.
United Transformer Corp.

ELECTROANALYSIS APPARATUS
Coleman Electric
Emby Products
Schaar & Co.

ELECTROMETERS, Quadrant
Cambridge Inst. Co.
Central Scientific Co.
Pfaltz & Bauer, Inc.
Rubicon Co.
Testrite Instrument Co.
Welch Mfg. Co.

ELECTROMETERS, String
Cambridge Inst. Co.
Dearborn Scientific
Geophysical Inst. Co.
Pfaltz & Bauer, Inc.

ELECTRONIC METERS (See Meters, Electronic)

ELECTROPLATING SOLUTION TESTING APPARATUS
Central Scientific Co.
Fisher Scientific Co.
Hellige, Inc.
Industrial Insts. Inc.
Pfaltz & Bauer, Inc.
Sargent & Co
Taylor & Co., W. A.
Thwing-Albert Inst. Co.

ELECTROSCOPES
Chicago Apparatus Co.
Denver Fire Clay Co.
Geophysical Inst. Co.
Henson, Fred C.
Pfaltz & Bauer, Inc.

ELLIPSOGRAPHS (See Drawing Instruments)

END MEASURES
Pratt & Whitney

ENGINE INDICATORS (See Indicators, Engine)

ENGINE INDICATOR REDUCING MOTION (See Reducing Motion, Engine Indicator)

EUDIOMETERS
Ace Glass Inc.
Central Scientific Co.
Eimer & Amend
Machlett & Son

EUSCOPES
Bausch & Lomb Optical

EXPANSION TEST APPARATUS (See Testers, Expansion)

EXTENSOMETERS
American Inst. Co.
Baldwin-Southwark Corp.
Brabender Corp.
Cambridge Inst. Co.
Eitzen Co.
Ferner Co.
Gen. Engg. & Model Wks.
Hayes Scientific Apps.
Metzger & Son
Olsen Testing Machine

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DIAL INDICATORS and GAGES

"If you haven't used one of these gages, you don't know their possibilities."

CALIPER GAGE — a very popular gage with hundreds of practical, everyday applications.

SNAP GAGE (adjustable)—no dependence on "feel". Dial tells at a glance the whole story.

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TESTMASTER Universal DIAL INDICATOR — small, accurate, compact and light. For general tool room and machine shop use.

These and hundreds of other Federal gages, adaptable to practically any gaging requirement, will help you accurately control dimensions in production and make possible fast, dependable final inspections. For further information, write

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PROVIDENCE 1, RHODE ISLAND

and now we've added the "White Star" to our flag.

COX
FLUTED GUIDE
Flow-Meter
PATENTS PENDING

One of the foremost developments in flow-meters is the fluted guide metering tube designed to maintain a high degree of accuracy under a wide range of operating conditions.

THE simplest and most accurate means of measuring the rate of flow of liquids and gases is the variable-area method which uses a tapered metering tube and a free-moving float.

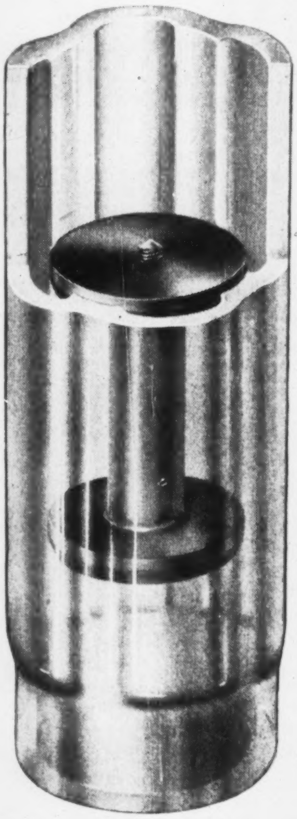
Integral Guides →

The new COX FLOWMETER has a precision-moulded pyrex metering tube with four integral guides. The closely-fitted, spool-shaped float moves without friction on the exact centerline of the tube. An unusually high degree of accuracy is maintained with a minimum length of metering tube.

Metering Float →

The standard FLOWMETER for the Aircraft Industry has seven stages with a total scale length of 10½ feet. The capacity range is from 5 to 4100 lbs. per hour. It is direct reading, with metering float always visible. ACCURACY AND PERFORMANCE GUARANTEED.

SECTION OF FLUTED GUIDE METERING TUBE
Frictionless metering float guided at four points . . . Guides are integral part of metering tube.



Commercial Research
Laboratories, Inc.
(Formerly Commercial Engineering Laboratories)
ESTABLISHED 1912
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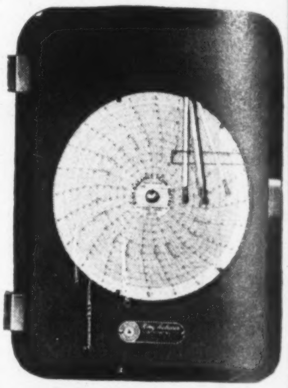
Detroit 3, Michigan

RING BALANC
FLOW METERS

Ring-Balance mechanical flow meters for every type of flow measurement—liquids—gases — oxygen — acids —for both low and high pressure — recording — integrating — indicating.

For accurate, dependable, year-in, year-out economical service, **Ring-Balance** instruments have earned an enviable reputation.

Ready Now!—New Series Improved Ring-Balance Mechanical Flow Meters Available for Prompt Deliveries.



Write for Bulletin T-44 explaining the many exclusive **Ring-Balance** features.

RING BALANCE
Ring Balance INSTRUMENT CO.
MECHANICAL FLOW METERS · PRESSURE & VACUUM RECORDERS
740 NORTH FRANKLIN STREET · CHICAGO 10, ILLINOIS

EYEGLASSES, POLARIZED (for Photoelastic Work or Strain Observation, etc.)
Polarizing Inst. Co.
Zeiss, Inc., Carl

FADE-OMETER
Atlas Elec. Devices Co.
Gen. Elec. Vapor Lamp

FAULT LOCATORS
Amer. Automatic Elec.
Industrial Insts. Inc.
Leeds & Northrup
Rawson Elec. Inst. Co.
Rubicon Co.
Shallcross Mfg. Co.
Tube Deutschmann Corp.

FEED WATER METERS
Bailey Meter Co.
Brown Inst. Co.
Builders-Providence
Central Station Steam
Cochrane Corp.
Elec. Indicator Co.
Fischer & Porter
Foxboro Co.
Henszey Co.
Leeds & Northrup
Mason-Neilan Regulator
Morey & Jones, Ltd.
Republic Flow Meters
Simplex Valve & Meter
Tagliabue Mfg. Co.

FEED WATER TESTING APPARATUS
Burrell Technical Supply
Central Scientific Co.
Cochrane Corp.
Electronic Products Co.
G. M. Mfg. Co., Inc.
Hellige, Inc.
Industrial Insts. Inc.
LaMotte Chemical Prod.
Leeds & Northrup Co.
Palo-Myers
Pfaltz & Bauer, Inc.
Taylor & Co., W. A.

FEEDERS, Automatic, Proportioning
Bowser & Co., S. F.
Everson Mfg. Co.
Graver Tank & Mfg.
Henszey Co.
Infilco Co.
Omega Machine
Permutit Co.

FEEDERS, Automatic, Granular Material
Infilco Co.
Omega Machine
Permutit Co.

FIELD RHEOSTATS (See Rheostats, Field)

FIELD-STRENGTH MEASURING SETS
Andrew, Victor J.
Federal Telegraph Co.
Ferris Inst. Corp.
McFarlin Co.
Measurements Corp.
RCA Manufacturing Co.
Tube Deutschmann Corp.

FILLING MACHINES, Automatic
Anderson Bros. Mfg. Co.
Bowser & Co.
Gump Co., B. F.
Richardson Scale Co.
Triangle Package Mach.

FILLING MACHINES, Bag
Gump Co., B. F.
Richardson Scale Co.
Triangle Package Mach.

FILLING MACHINES, Barrel
Bowser & Co.

FILLING MACHINES, Can
Anderson Bros. Mfg.
Bowser & Co.
Gump Co., B. F.
Triangle Package Mach.

FILLING MACHINES, Carton
Gump Co., B. F.
Triangle Package Mach.

FILTERS, Light (See also Filters, Optical)
American Inst. Co.
Bausch & Lomb Opt.
Buhl Optical
Central Scientific Co.
Corning Glass Works
Dearborn Scientific
Fish-Schurman Co.
Fuess, Inc.
Kollmorgen Optical Co.
Leitz, Inc.
Perkin-Elmer Corp.
Maxwell Smith Co.
Zeiss, Inc., Carl

FILTERS, Optical
Akatos, Inc.
Bausch & Lomb Optical
Binswanger & Co.
Buhl Optical
Dearborn Scientific
Electronic Laboratory
Fecker, J. W.
Fish-Schurman
General Scientific Corp.
Goerz Amer. Optical Co.
Klett Mfg. Co.
Maxwell Smith Co.
Mico Instrument Co.
Pfaltz & Bauer, Inc.
Rubicon Co.
Testrite Instrument Co.
Triumph Mfg. Co.
United Cinephone Corp.
Univis Lens Co.

FINDERS, VALVE BOX
Geophysical Inst. Co.

FIRE CONTROL INSTRUMENTS, MILITARY & NAVAL
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Buhl Optical
Elec. Indicator Co.
Fecker, J. W.
Kern Co.
Kollmorgen Optical Co.
Maxwell Smith Co.
Unertl Opt. Co.
United Cinephone Corp.

FIRING DISKS
Veritas Firing System

FLASH POINT TESTERS (See Testers, Flash Point)

FLASHERS, Neon Tube
Automatic Elec. Mfg. Co.
Bacharach Industrial Inst.
Betts & Betts
Paragon Electric Co.
Sangamo Electric Co.

FLATNESS TESTERS (See Testers, Flatness, Light Wave)

FLATS, OPTICAL
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Binswanger & Co.
Buhl Optical
Clark & Sons
Dearborn Scientific Co.
L[illegible]al Co.
English, R. E.
Fecker, J. W.
Ferrer Co.
Fish-Schurman Co.
Fuess, Inc.
Gaertner Scientific Corp.
General Scientific Corp.
Glendale Optical
Goerz Amer. Optical Co.
Kollmorgen Optical Co.
Master Optical Co.
Mico Instrument Co.
Miller Corp., William
Perkin-Elmer Corp.
Robinson Optical
Ruska & Co.
Scherr Co., Inc., George
Simpson Optical
Spencer Lens
Tinsley Laboratories
Unertl, John
Univis Lens Co.
Van Keuren Co.
Vard Inc.
Wilder, R. S.
Woertmann-Schuchhardt
Zeiss, Inc., Carl

FLATS, OPTICAL, Fused Quartz
Bausch & Lomb Op
Dearborn Scientific
Thermal Syndicate Ltd.

BUILDERS
RECORDING·INDICATING·CONTROLLING
Instruments
FOR
METERING FLOW
LIQUID LEVEL — WEIGHT

VENTURI
Builders Venturi-Meter is widely recognized as standard for measuring liquid flow in boiler rooms, water works, and sewage disposal plants. For the super-accuracy required by central stations, each Type M is adjusted to match exactly its University-Calibrated Venturi Tube. Write for Bulletin 324.

CHRONOFLO
Builders Chronoflo Telemeter brings measurements of flow, level, pressure, temperature, and weight from any distance to centrally located indicating and recording instruments. Write for Bulletin 320. Toledo Chronoflo Conveyor Scales are illustrated and described in Bulletin 322.

SHUNT
Hundreds of firms have purchased Builders Shunt Meters to measure steam, air, or gas that they sell to customers or distribute to various departments. Bolts directly into line; uses no mercury; has no clock to wind; requires no power supply. Write for Bulletin 307.

FLO-WATCH
An attractive flow meter, accurate and good-looking. This recording, indicating, and totalizing meter is designed and priced to allow wide use throughout the plant. Equally serviceable with Venturi Tube, Flow Nozzle or Orifice Plate. Write for Bulletin 318A.

ADDRESS BUILDERS-PROVIDENCE, INC.,
44 CODDING ST., PROVIDENCE 1, R. I.

Sincerely Yours

BUILDERS - PROVIDENCE

FLIGHT TEST INSTRUMENTS
Cannon Co.
Globe Industries
Impact Register
Televiso Products

"FLOW"

(Flowmeters measure primarily RATE of flow. For positive or "quantity" fluid meters, see the numerous classes under "Meters")

FLOWMETERS, AIR
(See Flowmeters, Gas)

FLOWMETERS, AREA
Cone & Disk Type
Cochrane Corp.
Commercial Research
Fischer & Porter
Friez & Sons
National Meter Co.

FLOWMETERS, AREA
Cylinder & Piston Type
American Inst. Co.
Bowser & Co.
Brown Inst. Co.
Fischer & Porter
National Meter Co.
New Jersey Meter Co.

FLOWMETERS, AREA
Free Float Type
Am. Gas Furnace Co.
Commercial Research
D'Este Co.
Fischer & Porter
Fish-Schurman Corp.
Hoke, Inc.
Schutte & Koerting Co.

FLOWMETERS, AREA
Orifice & Plug Type
American Meter Co.
Bacharach Industrial Inst.
Brown Inst. Co.
Cochrane Corp.
Fischer & Porter
Mason-Neilan Regulator
Republic Flow Meters
Taylor Inst. Cos.
Trimount Instrument

FLOWMETERS, BLAST
(See Flowmeters, Gas)

FLOWMETERS, GAS
Ace Glass, Inc.
American Gas Furnace
American Inst. Co.
American Meter Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Bowser & Co.
Bristol Co.
Brown Inst. Co.
(Cont'd)

FLOWMETERS, Gas (Cont'd)
Builders-Providence
Clark Blast Meter
Cochrane Corp
Commercial Research
Corning Glass Works
D'Este Co.
Detroit Air Meter Co.
Eclipse Aviation
Elec. Indicator Corp.
Fischer & Porter
Fish-Schurman Co.
Foxboro Co.
Friez & Sons
Gas Appliance Specialties
Henszey Co.
Hoke, Inc.
Ill. Testing Labs.
International Filter Co.
Kollsman Inst. Co.
Lambert Meter Co.
Leeds & Northrup
Leupold, Volpel & Co.
Mason-Neilan Regulator
Meriam Co.
Morey & Jones, Ltd.
National Meter Co.
New Jersey Meter Co.
Pioneer Instrument
Republic Flow Meters
Ring Balance Co.
Schutte & Koerting Co.
Scientific Glass Apparatus
Selas Company
Simplex Valve & Meter
Superior Meter Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trimount Instrument
Victor Equipment Co.

FLOWMETERS, LIQUID
(See Flowmeters, Gas)

FLOWMETERS, Open-Stream
Bristol Co.
Builders-Providence
Cochrane Corp.
Leupold & Stevens
Mason-Neilan Regulator
Morey & Jones, Ltd.
Republic Flow Meters
Scientific Inst. Co Calif.
Simplex Valve & Meter

FLOWMETERS, Orifice, and Nozzle
Ace Glass Inc.
American Meter Co.
Askania Regulator Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Builders-Providence
(Cont'd)

FLOWMETERS, Orifice & Nozzle (Cont'd)
Cochrane Corp.
Corning Glass Works
Eimer & Amend
Fischer & Porter
Foxboro Co.
Hoke, Inc.
Lambert Meter Co., Inc.
Leeds & Northrup Co.
Leupold & Stevens
Mason-Neilan Regulator
Meriam Co.
Moore Products
Morey & Jones, Ltd.
Permutit Co.
Pgh. Equitable Meter
Republic Flow Meters
Ring Balance Co.
Roska & Co. Inc.
Schutte & Koerting
Scientific Glass Apparatus
Scientific Inst. Co.
Simplex Valve & Meter
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trimount Instrument

FLOWMETERS, Pitot Tube
Am. Blower Corp.
American Meter Co.
Askania Regulator Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Bristol Co.
Cambridge Inst. Co.
Central Scientific Co.
Cochrane Corp.
Defender Automatic Reg.
Detroit Air Meter Co.
Foxboro Co.
Friez & Sons
Fuess, Inc.
Kollsman Inst. Co.
Leupold & Stevens
Meriam Co.
Morey & Jones, Ltd.
Pitometer Log Corp.
Precision Therm. & Inst.
Refinery Supply Co.
Republic Flow Meters
Ring Balance Co.
Simplex Valve & Meter
Taylor Inst. Cos.
Trimount Instrument

FLOWMETERS, Steam
Am. Dist. Steam Co.
American Meter Co.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Cochrane Corp.
Fischer & Porter
Foxboro Co.
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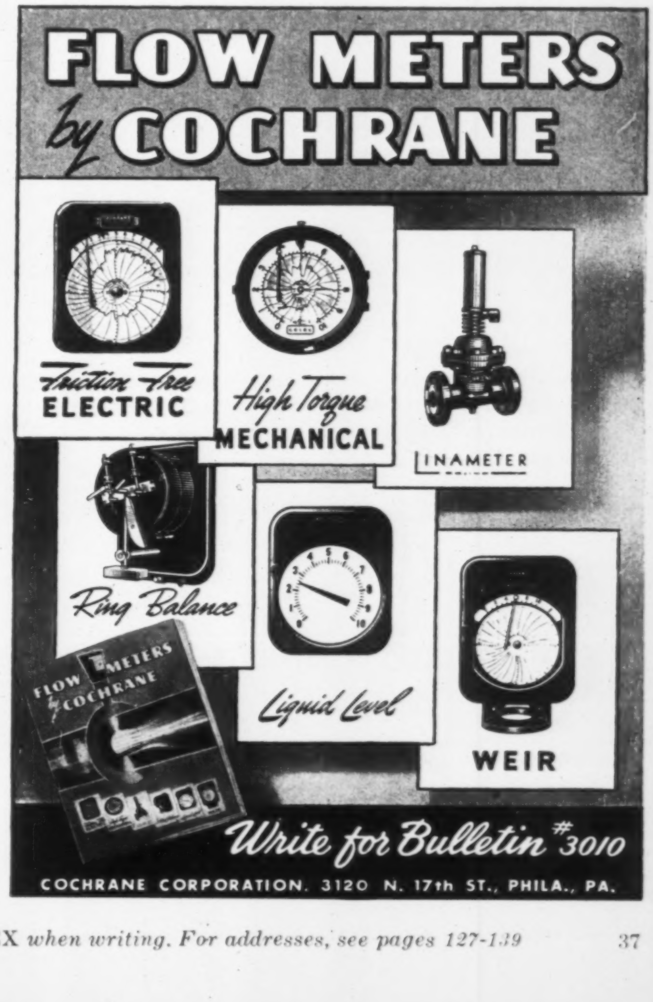
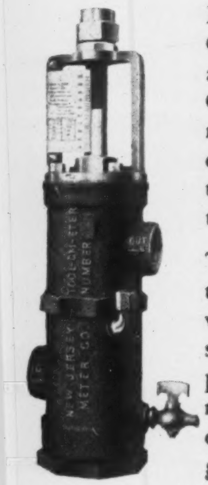

FLOW METERS by COCHRANE
Friction Free ELECTRIC
High Torque MECHANICAL
LINAMETER
Ring Balance
Liquid Level
WEIR
Write for Bulletin #3010
COCHRANE CORPORATION. 3120 N. 17th ST., PHILA., PA.

New Jersey Air Meters

TOOL-OM-ETER and DRILL-OM-ETER



Measure the flow of Compressed Air to any process or tool. Guide the maintenance of pneumatic equipment in effective working condition.

These meters are of the constant head, variable orifice type, simple, reliable, portable, only one moving part. Used on air and other gases at 1-300 lb.

New Jersey Meter Co.
PLAINFIELD, N. J.

FLOWMETERS, Steam (Cont'd)
- Leeds & Northrup Co.
- Mason-Neilan Regulator
- Meriam Co.
- Morey & Jones, Ltd.
- Republic Flow Meters
- Ring Balance Co.
- Simplex Valve & Meter
- Tagliabue Mfg. Co.
- Taylor Inst. Cos.

FLOWMETERS, Vane
- Autocall Co.
- Detroit Air Meter Co.
- Friez & Sons
- Ill. Testing Labs.
- Mason-Neilan Regulator
- Simplex Valve & Meter

FLOWMETERS, Venturi Type
- Bailey Meter Co.
- Bristol Co.
- Brown Inst. Co.
- Builders-Providence
- Cochrane Corp.
- Foxboro Co.
- International Filter Co.
- Leeds & Northrup
- Leupold & Stevens
- Mason-Neilan Regulator
- Morey & Jones, Ltd.
- Republic Flow Meters
- Ring Balance Co.
- Simplex Valve & Meter
- Taylor Inst. Cos.

FLOWMETERS, Weir
- Bailey Meter Co.
- Bristol Co
- Brown Inst. Co.
- Builders-Providence
- Cochrane Corp.
- Elec. Indicator Corp.
- Fischer & Porter
- Foxboro Co.
- Gurley, W. & L. E.
- Leupold & Stevens
- Mason-Neilan Regulator
- Morey & Jones, Ltd.
- Simplex Valve & Meter
- Taylor Inst. Cos.

FLUE GAS ANALYZERS (See Gas Analyzers, Flue Gas)

FLUID METERS, GAS (See Gas Meters)

FLUID METERS, LIQUID (See Meters, Liquid)

FLUID METERS, QUANTITY (See Gas Meters; Meters, Current; Meters, Liquid)

FLUORESCENT CHEMICALS
- Central Scientific Co.
- Pfaltz & Bauer, Inc.
- Patterson Screen Co.
- Laboratory Specialties

FLUORESCENCE
- Ultra-Violet Products

FLUORESCENT PAINT, APPLIED
- Canadian Radium
- General Luminescent

FLUORESCENT MERCURY VAPOR TUBES EMITTING WHITE LIGHT (See Light Sources)

FLUOROSCOPES
- General Electric X-Ray
- Patterson Screen Co.
- Westinghouse X-Ray Co.

FLUXMETERS
- Annis Co.
- Cambridge Inst. Co.
- Central Scientific Co.
- General Elec. Co.
- Leeds & Northrup Co.
- Rawson Electrical Inst.
- Readrite Meter Wks.
- Rubicon Co.
- Sensitive Research Inst.

FOLDING ENDURANCE TESTERS (PAPER) (See Testers, Folding Endurance)

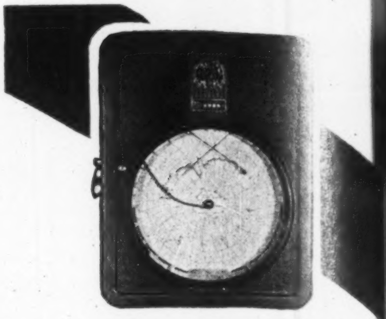
FOOT BLOCKS
- Ford Motor Co.

FOOT CANDLE METERS
- Central Scientific Co.
- Cole Instrument
- De Jur-Amsco Corp.
- General Elec. Co.
- G-M Labs.
- Pfaltz & Bauer, Inc.
- Photovolt Corp.
- Triplett Elec. Inst.
- United Cinephone Corp.
- Weston Elec. Inst. Corp.

FOREWARN DETECTOR, for locating hidden weapons (See Detectors, Metal)

FORKS, Synchronization
- American Time Prods.
- Elec. Tachometer Corp.
- Gaertner Scientific Corp.
- Riverbank Laboratories

FORKS, Tuning
- American Time Prods.
- Clay-Adams Co.
- Hathaway Instrument



BAILEY

Fluid Meters

For STEAM · LIQUIDS · GASES

● Bailey Fluid Meters are designed to indicate, record and integrate the flow of steam, liquids, or gases under practically any pressure or temperature condition.

A great variety of indicating, recording and integrating combinations are available for use with four distinct types of flow mechanisms.

This large variety of possible combinations enables the flow meter engineer to specify equipment which is pre-eminently suited to any flow measuring application.

When it is desired to place indicators, recorders and integrators at a considerable distance from the primary element, Bailey Synchro-Meters are available to provide electric transmission.

For detailed information consult Sweet's Engineering Catalogs or request a copy of bulletin No. 301.

BAILEY METER COMPANY
1041 IVANHOE ROAD · CLEVELAND, O.
Bailey Meter Company Ltd., Montreal, Canada

ULTRA-VIOLET

Lamps for All Purposes

MINERALIGHT

Fluorescent black light mining lamps for instant identification of scheelite and fluorescent chemical analysis.

Life Lite

Therapeutic health lamps of finest quality.

STERILAIRE

Commercial ultra-violet installations for sterilization — air conditioning—refrigeration

ALL LAMPS GUARANTEED TO GIVE SATISFACTION OR MONEY REFUNDED.

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ULTRA-VIOLET PRODUCTS, Inc.
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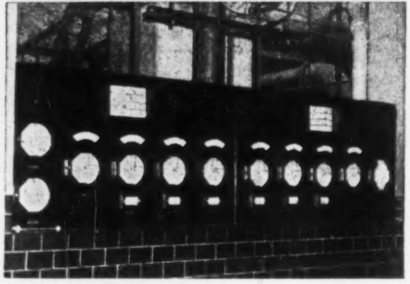
FLOW METERS



For Measuring the Flow of Steam-Water-Gas-Air-Oil

WORKING PRESSURES
Republic meters are available for all working pressures up to 5000 lb. per sq. in.

RANGE EASILY CHANGED
The range of a Republic meter can be easily and quickly changed by merely changing the range tube.

READING INSTRUMENTS
The Republic indicator, recorder and integrator operate independently of each other and can be supplied separately or in combination. They are remote reading.

EASILY READ
The indicator scale and the recorder chart all have uniform graduations and are direct reading. The integrator has a large cyclometer type dial.

WRITE FOR DATA BOOK No. 701

REPUBLIC FLOW METERS CO.
2249 DIVERSEY PKWY., CHICAGO, ILLINOIS

Stevens

WATER LEVEL and FLOW RECORDERS

(DIRECT FLOAT OPERATED & REMOTELY CONTROLLED)

o

INDICATORS

o

AUTOMATIC CONTROLS

LEUPOLD & STEVENS INSTRUMENTS

Hydrographic, Navigation, Surveying

4445 N. E. GLISAN STREET
PORTLAND OREGON

J-B-T

PORTABLE POTENTIOMETER-PYROMETERS

For quickly measuring and following temperatures where permanent thermocouple installations are not available; for checking existing pyrometers, recorders or controllers; for laboratory testing of instruments and materials; and as temporary substitute for instruments being repaired or replaced.

Measures temperatures from sub-zero to 3000°F. New in principle, requires no standard cell, and on most ranges, once balanced and adjusted, this instrument follows temperature changes as they occur *without further balancing.* Accurate to ½ of 1% of total scale deflection. Withstands vibration, and is compensated for changes in ambient temperature from −40°F. to 120°F. Ask for Bulletin 540-70 PO.

MODEL 70-PO

J-B-T *Products*

Vibrating Reed Frequency Meters... Pyrometers... Potentiometer-Pyrometers... Resistance Thermometers... Thermocouples and Accessories... Electric Tachometers... Galvanometers... Selector Switches...and other Electrical Instruments and Testing Equipment.

(Manufactured under Triplett Patents and/or Patents Pending)

J-B-T INSTRUMENTS, INC.

443 CHAPEL STREET • NEW HAVEN 8, CONN.

ORKS, Tuning, Electrically Driven
American Inst. Co.
American Time Prods.
Cambridge Inst. Co.
Central Scientific Co.
Chicago Apparatus Co.
Elec. Tachometer Corp.
Engineering Labs., Inc.
Gaertner Scientific Corp.
General Radio Co.
Hathaway Inst. Co.
Metron Instrument
Riverbank Laboratories
Welch Mfg. Co.

ORKS, Vacuum Driven
Cambridge Inst. Co.
Gaertner Scientific Corp.
Riverbank Laboratories

RACTIONAL HORSE-POWER MOTORS (See Motors, Fractional Horsepower)

REENESS TESTERS (See Testers, Freeness)

REQUENCY METERS, Controlling
Doolittle Radio
General Elec. Co.
Leeds & Northrup Co.

REQUENCY Meters, Electronic
De Jur-Amsco Corp.
Garner Electronics
General Radio Co.
Lavoie Laboratories
Metron Instrument
RCA Manufacturing Co.

REQUENCY METERS, Indicating
General Elec. Co.
General Radio Co.
Hagedorn Engineering
Hathaway Instrument
Hickok Elec. Inst. Co.
J-B-T Instruments
Leeds & Northrup Co.
Metron Instrument
RCA Manufacturing Co.
Roller-Smith Co.
Sensitive Research Inst.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

FREQUENCY METERS, Recording
Bristol Co.
Esterline-Angus Co.
General Elec. Co.
Leeds & Northrup Co.
Metron Instrument
Roller-Smith Co.
Warren Telechron Co.
Westinghouse Elec. & Mfg.

FREQUENCY METERS, Standards
American Time Prods.
Bliley Electric Co.
Doolittle Radio
Ferris Inst. Corp.
Garner Electronics
Hathaway Instrument
Millen Mfg. Co.
RCA Manufacturing Co.

FREQUENCY METERS Vibrating Reed
Biddle Co., Jas. G.
Hagedorn Engineering
J-B-T Insts., Inc.
Triplett Elec. Inst.
Wirshing Mfg. Co.

FREQUENCY RESPONSE RECORDERS, Automatic
Sound Apparatus Co.

FRITTED GLASS FILTERS & APPARATUS
Central Scientific Co.
Corning Glass Works
Fischer & Porter
Fish-Schurman Co.
Pfaltz & Bauer, Inc.

FUEL ANALYSIS APPARATUS
Burrell Tech. Supply
Central Scientific Co.
Eimer & Amend
Machlett & Son
Parr Instrument Co.
Precision Scientific Co.
Sargent & Co.
Tagliabue Mfg. Co.

FUEL FLOW INDICATORS
Askania Regulator Co.
Autocall Co.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
(Cont'd)

FUEL FLOW INDICATORS (Cont'd)
Commercial Research
Eclipse Aviation
Fischer & Porter
Foxboro Co.
Mason-Neilan Regulator
National Airoil Burner
Pioneer Instrument
Schutte & Koerting
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Technicraft Indicators
Victor Equipment Co.

FURNACE CONTROL SYSTEMS (See Controllers, Automatic)

FURNACES, LABORATORY, HIGH TEMPERATURE
American Instrument Co.
Gordon Co., Claud S.
Johnson Gas Appliance
Laboratory Equipment
Machlett & Son
National Airoil
Schaar & Co.
Selas Co.
Shallcross Controls

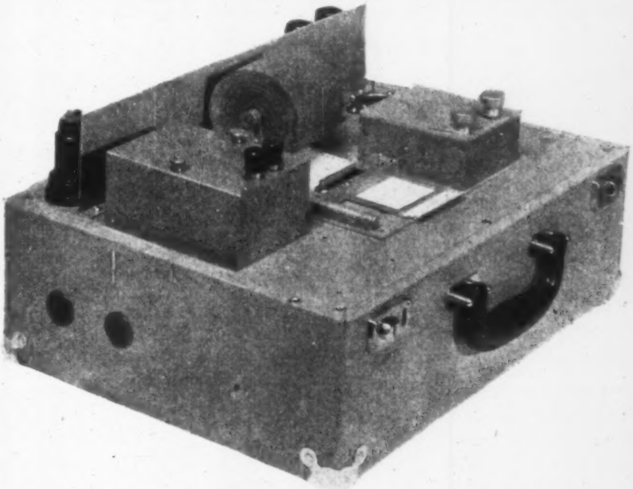
FURNITURE, LABORATORY
Hamilton Mfg. Co.
Kewaunee Mfg. Co.
Kimball Co., W. W.
Laboratory Const. Co.
Laboratory Furniture Co.
Moline Furniture Works
Sheldon & Co.
Sjostrom Co.
Southern Desk Co.
Welch Mfg. Co.

FUSES, INSTRUMENT
Littelfuse Labs.
Meter Devices Co.

GAGE BLOCKS
Dearborn Gage Co.
Dearborn Scientific
Ford Motor Co.
Illinois Tool Works
Jansson Gage Co.
Lincoln Park Tool
Pratt & Whitney
Savage Tool Co.
Sc . Co., George
Standard Gage Co.
Van Keuren Co.
Webber Gage Co.

AUTOMATIC HIGH SPEED POWER LEVEL RECORDER MODEL PL

The Fastest Recording Instrument on the Market

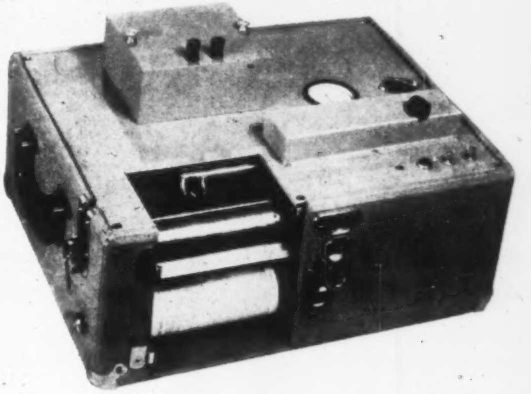


Designed especially for acoustical measurements such as reverberation time, sound decay, sound absorption, but also ideal for vibration and noise measurements. Also applicable to current and voltage measurements.

The recording is on a 2″ chart and can be made either on a logarithmic (db) or linear (current/voltage), or on a loudness (phon) scale. Two writing and two chart speeds.

Write for descriptive bulletin.

AUTOMATIC FREQUENCY RESPONSE RECORDER MODEL FR



For drawing automatically and accurately the frequency characteristic of any audio apparatus or complete installation.

4″ chart; ink-writing. Applicable to voltage and current measurements, sound intensity, vibration, etc.

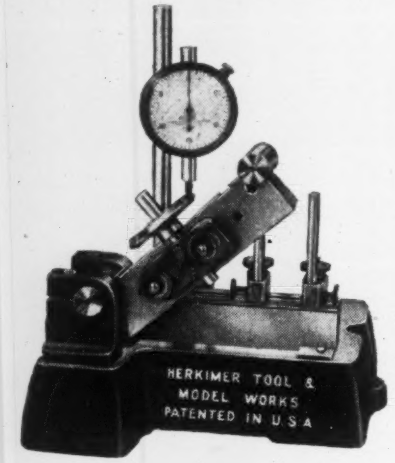
Full technical data given in our bulletin "Sound Advances."

SOUND APPARATUS COMPANY

150 WEST 46 STREET NEW YORK, N. Y.

Specialists in Designing and Manufacturing of Graphic Recording Instruments

BEVEL GEAR GAUGES and SINE BARS



A New, Simplified Gauging Method

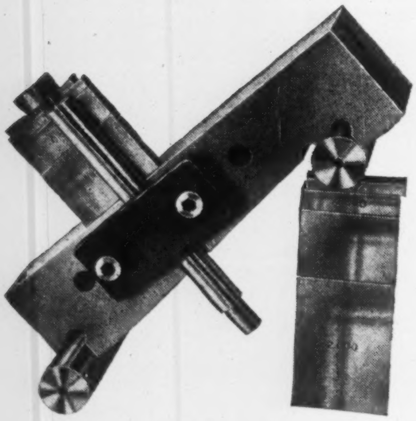
Reduces bevel gear gauging to the simplest and most accurate form.

No difficult computations or operations.

Checks dimensional accuracy of addendum cone (gear face) as related to thrust face of hub.

Checks accuracy of cone angle.

Checks run-out of gear face.



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HERKIMER TOOL & MODEL WORKS

1010 George St. Herkimer, N. Y.

GAGE GLASS ILLUMINATORS
- Wright-Austin Co.

GAGE TESTERS, Deadweight
- American Inst. Co.
- Amthor Testing Inst. Co.
- Ashton Valve Co.
- Crosby Steam Gage Co.
- Grove Regulator
- Manning, Maxwell & Moore
- Olsen Testing Machine
- Pioneer Instrument
- Refinery Supply Co.
- Star Brass Mfg. Co.

GAGE TESTERS, Fluid-scale
- Crosby Steam Gage Co.

GAGE TESTERS, Liquid-column
- Ideal Lab. Tool
- Manning, Maxwell & Moore
- Pioneer Instrument

GAGES (See also object of Measurement and control)

GAGES, Absolute Pressure
- Bailey Meter Co.
- Bristol Co.
- Brown Inst. Co.
- Clapp Instrument
- Foxboro Co.
- Kollsman Inst. Co.
- Manning, Maxwell & Moore
- Mason-Neilan Regulator
- Moeller Instrument Co.
- Pioneer Instrument
- Precision Therm.
- Scientific Inst. Co.
- Tagliabue Mfg. Co.
- Taylor Inst. Cos.
- Uehling Instrument Co.
- United States Gauge Co.
- Victor Equipment Co.

GAGES, Adjustable Length
- Merz Engineering
- Scherr Co., George
- Size Control Co.
- Vinco Corp.

GAGES, Air
- Ashton Valve Co.
- Bailey Meter Co.
- Bastian-Blessing Co.
- Bristol Co.
- Clapp Instrument
- Detroit Air Meter Co.
- Electric Auto-Lite
- Foxboro Co.
- Friez & Sons
- Lambert Meter Co., Inc.
- Manning, Maxwell & Moore
- Marsh Corp.
- Mason-Neilan Regulator
- Rochester Mfg. Co.
- Sheffield Corp.
- Star Brass Mfg.
- Tagliabue Mfg. Co.
- Trerice Co.
- Uehling Inst. Co.
- U. S. Gage Co.
- Victor Equipment Co.

GAGES, Alarm
- Ashton Valve Co.
- Bailey Meter Co.
- Bristol Co.
- Foxboro Co.
- Manning, Maxwell & Moore
- Marsh Corp.
- Mason-Neilan Regulator
- Precision Therm. & Inst.
- Star Brass Mfg.
- Trerice Co.
- U. S. Gage Co.
- Wheelco Instruments

GAGES, Amplifying
- Coats Mach. Tool Co.
- Comtor Co.
- Federal Prod. Corp.
- Precision Gage & Tool
- Saxl Instr. Co.
- Sheffield Corp.
- Swedish Gage
- United Cinephone Corp.

GAGES, Automatic Sorting
- Electric Sorting Machine
- Hathaway Instrument
- Heyman Co.
- Instrument Specialties Co
- Rowe Radio Research

GAGES, Bore
- Brown & Sharpe
- Comtor Co.
- Federal Prod. Corp.
- Gauthier, Donat
- Merz Engineering
- Poole Manufacturing
- Pratt & Whitney
- Scherr Co.
- Sheffield Corp.
- Size Control Co.

GAGES, Bourdon
- Ashton Valve Co.
- Bailey Meter Co.
- Baldwin-Southwark Corp.
- Bastian-Blessing Co.
- Belfield Co.
- Bristol Co.
- Brown Inst. Co.
- Clapp Instrument
- Crosby Steam Gage
- Dickson Co.
- Electric Auto-Lite
- Foxboro Co.
- Hays Corp.
- Heise Bourdon Tube
- Hoke, Inc.
- Manning, Maxwell & Moore
- Marsh Corp.
- Mason-Neilan Regulator
- Mercoid Corp.

(Cont'd)

GAGES, Bourdon (Cont'd)
- Pioneer Instrument
- Republic Flow Meters
- Star Brass Mfg. Co.
- Tagliabue Mfg. Co.
- Taylor Inst. Cos.
- Trerice Co.
- United States Gauge Co

GAGES, Caliper (Dial)
- Brown & Sharpe
- Federal Prod. Corp.
- Glogau & Co.
- Starrett Co.

GAGES, Center
- Lufkin Rule Co.
- Millers Falls Co.
- Starrett Co.
- Union Tool Co.

GAGES, Comparator
- Ames Co., B. C.
- Center Scope Inst.
- Coats Mach. Tool Co.
- Comtor Co.
- Federal Prod. Corp.
- Gauthier, Donat
- General Engg. & Model
- Hathaway Instrument
- Instrument Specialties Co.
- Jones & Lamson Machine
- Metron Instrument
- Moore Products
- Pratt & Whitney
- Precision Gage & Tool
- Saxl Inst. Co.
- Scherr Co.
- Sheffield Corp.
- United Cinephone Corp.
- Vard, Inc.
- Vinco Corp.

GAGES, Compression
- Bacharach Indus Inst.
- Baldwin Southwark
- G. M. Co. Mfg.
- Riehle Div.
- Saxl Inst. Co.
- Toledo Scale Co.
- United States Gauge Co.

GAGES, Continuous, Thickness
- Merz Engineering
- Pratt & Whitney
- Televiso Products
- Saxl Instrument
- Vinco Corp.

GAGES, Continuous, Width
- Merz Engineering
- Vinco Corp.

GAGES, Contour see Gages, Profile

GAGES, Cylinder
- Ames Co., B. C.
- Coats Mach. Tool
- Comtor Co.
- Federal Prod. Corp.
- Lufkin Rule Co.
- Merz Engineering
- Pratt & Whitney
- Sheffield Corp.
- Starrett Co.
- Swedish Gage
- United Cinephone
- Victor Equipment

GAGES, Dead Weight
- American Instrument
- Eastern Specialty
- Grove Regulator
- Manning, Maxwell & Moore
- Star Brass

GAGES, Depth, Linear
- Ames Co., B. C.
- Brown & Sharpe
- Carson Micrometer
- Glogau & Co
- Jansson Gage Co.
- Lincoln Park Tool & Gage
- Lufkin Rule Co.
- Merz Engineering
- Park Sales
- Pratt & Whitney
- R & M Mfg. Co.
- Ryan Tool & Engg.
- Sheffield Corp
- Size Control Co.
- Starrett Co
- Swedish Gage
- Union Tool Co.
- Vinco Corp.

GAGES, Depth, Navigational
- Geophysical Inst. Co.

GAGES, Dial, Machinists'
- Ames Co., B. C.
- Brown & Sharpe
- Chicago Dial Ind.
- Federal Prod. Corp.
- Ferner Co.
- Genales, Andrew
- General Engg & Model
- Micro Master Co.
- Randall, Frank E.
- Size Control Co.
- Starrett Co.
- Waltham Dial Gage

GAGES, Differential Pressure
- American Meter Co.
- Bacharach Industrial Inst.
- Bailey Meter Co.
- Boiler Room Equip.
- Bristol Co.
- Brown Inst. Co.
- Builders-Providence
- Crosby Steam Gage
- Defender Automatic Reg.
- Detroit Air Meter Co.
- Dwyer Mfg. Co.

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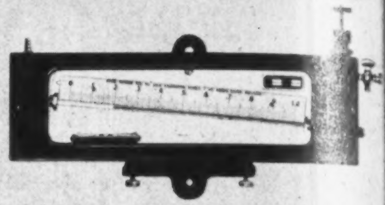
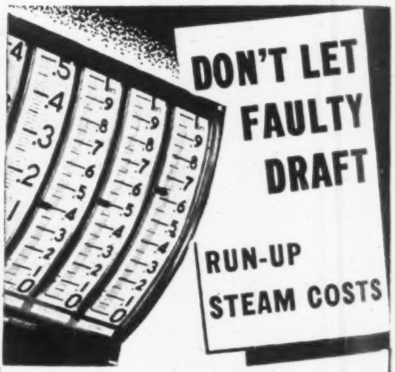
DRAFT GAUGES



• These are extremely serviceable direct reading instruments for measuring low pressures, drafts and differentials—built with inclined tubes to give increased scale length and permit the taking of readings in fractional inches of water. Each instrument individually calibrated to assure extremely accurate operation. Oil or mercury filled tubes. Also two-tube and three-tube models for taking multiple readings with the same gauge. Fully descriptive catalog sent on request.

THE MERIAM CO.
CLEVELAND, OHIO

Manometers, Meters, and Gauges for the accurate measurement of Pressures, Vacuums and Flows of Liquids and Gases.



MAINTAINING PROPER DRAFT is relatively a simple job once a Hays Draft Gage has been installed. Accurate measurements supplant guesswork, resulting in more efficient combustion.

HAYS ORIGINATED and perfected the dry or diaphragm type of draft gage and today Hays Draft Gages are standard equipment in thousands of the nation's boiler rooms.

HAYS DRAFT GAGES are offered in a wide variety of types from the V-type, illustrated above, to recording gage. Send for our catalog today. Write to 925 Eighth Avenue, Michigan City, Indiana.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

GAGES, Differential Pressure (Cont'd)
- Ellison Draft **Gage Co.**
- Foxboro Co.
- Friez & Sons
- Fuess, Inc.
- Gas Appliance **Specialties**
- Hays Corp.
- Kollsman **Instrument**
- Lambert Meter Co.
- Leupold & Stevens
- Manning, Maxwell & Moore
- Mason-Neilan **Regulator**
- Meriam Co.
- Metron Instrument
- Moeller **Instrument**
- Moore Products **Co.**
- Morey & **Jones, Ltd.**
- Pioneer **Instrument**
- Pitometer Log Corp.
- Precision **Scientific**
- Precision **Therm.**
- Preferred Utilities Mfg.
- Republic Flow Meters
- Scientific **Glass Apparatus**
- Scientific Inst. Co.
- Simplex Valve & Meter
- Star Brass
- Tagliabue **Mfg. Co.**
- Taylor **Inst. Co.**
- Trimount **Instrument**
- Uehling **Instrument Co.**
- U. S. Gauge Co.

GAGES, Draft (See Gages, Differential Pressure)

GAGES, Drill Grinding
- Lufkin Rule Co.
- Morse Twist Drill
- Size Control Co.
- Starrett Co.

GAGES, Feeler
- Improved Gauge Mfg.
- Lufkin Rule Co.
- Millers Falls Co.
- Size Control Co.
- Starrett Co.
- Swedish Gage
- Union Tool Co.
- **Van Keuren Co.**
- Vinco Corp.

GAGES, Flush Pin
- Acme Industrial
- Jansson Gage Co.
- Lawrence & Hill
- Merz Engineering
- Swedish Gage
- Vinco Corp.

GAGES, Gas
- **Abercrombie Pump Co.**
- **American Meter Co.**
- **Bailey Meter Co.**
- **Bastian-Blessing**

(Cont'd)

GAGES, Gas (Cont'd)
- **Bristol Co.**
- Connelly Iron Sponge
- Detroit Air Meter
- Dickson Co.
- **Foxboro Co.**
- Gas Appliance Specialties
- Lambert Meter Co.
- **Mason-Neilan Regulator**
- Rochester Mfg. Co.
- Specialty Glass Co.
- Superior Meter Co.
- **Tagliabue Mfg. Co.**
- **Taylor Inst. Cos.**
- Victor Equipment

GAGES, Grinding
- **Ames Co., B. C.**
- Brown & Sharpe
- Comtor Co.
- **Federal Prod. Corp.**
- Lufkin Rule Co.
- Merz Engineering
- Moore Products
- Sheffield Corp.

GAGES, Height
- Brown & Sharpe
- **Ford Motor Co.**
- General Engg. & Model
- Jansson Gage Co.
- Lufkin Rule Co.
- Merz Engineering
- Ryan Tool & Engg.
- Scherr Co.
- Sheffield Corp.
- Starrett Co.
- Vinco Corp.

GAGES, Hook
- Gurley, W. & L. E.
- Leupold & Stevens
- Scientific Inst. (Calif.)
- White Co. Inc.

GAGES, Hydrostatic (See Gages, Liquid Level, Indicating)

GAGES, Internal Dial
- Coats Mach. Tool
- Comtor Co.
- **Federal Prod. Corp.**
- Gen. Engg. & Model Wks.
- Scherr Co.
- Swedish Gage

GAGES, Limit
- Detroit Tap & Tool
- **Ford Motor Co.**
- **Fox Munitions**
- General Elec. Co.
- Gen. Engg. & Model Wks.
- Greenfield Tap & Die
- Jansson Gage Co.
- Metron Instrument
- Merz Engineering

(Cont'd)

GAGES, Limit (Cont'd)
- M-G Gage Corp.
- Pratt & Whitney
- Sheffield Corp.
- **Size Control Co.**
- Swedish Gage
- United Cinephone
- **Van Keuren Co.**
- Vinco Corp.

GAGES, Liquid Level, Indicating
- **American Meter Co.**
- **Anderson Co.**
- **Ashton Valve Co.**
- Autocall Co.
- Bacharach Industrial Inst.
- **Bailey Meter Co.**
- Bastian-Blessing
- Belfield Co.
- **Bin-Dicator Co.**
- Boston Auto Gage
- Bowser & Co.
- **Bristol Co.**
- **Brown Inst. Co.**
- **Builders-Providence**
- Burt Scientific Labs.
- **Certified Gauge**
- Clapp Instrument
- **Cochrane Corp.**
- Crosby Steam Gage
- Davis Reg. Co.
- Defender Automatic Reg.
- Dickson Co.
- Electric Auto-Lite
- Elec. Indicator Corp.
- **Elec. Tachometer Corp.**
- **Fisher Governer Co.**
- **Foxboro Co.**
- Frick Co.
- **General Controls Co.**
- **General Elec. Co.**
- **Gorrell & Gorrell**
- Gurley, W. & L. E.
- Hanlon-Waters, Inc.
- Infilco, Inc.
- **Jerguson Gage Co.**
- Kellogg Switchboard
- **King Engineering**
- Klingerit, Inc.
- **Leeds & Northrup Co.**
- Leupold & Stevens
- **Liquidometer Co.**
- **Lumenite Elec. Co.**
- Manning, Maxwell & Moore
- **Marsh Corp.**
- **Mason-Neilan Regulator**
- McAlear Mfg. Co.
- McNeill Engr. Equip.
- **Meriam Co.**
- Moore Products
- **Morey & Jones, Ltd.**
- Nathan Mfg. Co.
- Natural Gas Equipment
- Paragon Electric
- **Penberthy Injector Co.**
- **Petrometer Corp.**
- Pioneer Instrument Co.
- Pneumercator Co., Inc.
- **Precision Therm.**
- Preferred Utilities Mfg.
- Reliance Gauge Column
- Republic Flow Meters
- Rochester Mfg. Co.
- Schutte & Koerting Co.
- Simplex Valve & Meter
- Star Brass Mfg.
- **Tagliabue Mfg. Co.**
- **Taylor Inst. Cos.**
- **Trimount Instrument**
- **Uehling Instrument Co.**
- **U. S. Gauge Co.**
- Vapor Recovery Systems
- Wallace & Tiernan
- Westinghouse Elec. & Mfg.
- **Wheelco Inst. Co.**
- Williams Gauge Co.
- Wright-Austin Co.
- Yarnell-Waring Co.

GAGES, Liquid Level, Recording (See Gages, Liquid Level, Indicating)

GAGES, Loss of Head
- **Bailey Meter Co.**
- **Bristol Co.**
- **Builders-Providence**
- **Foxboro Co.**
- International Filter Co.
- **Morey & Jones, Ltd.**
- Star Brass
- **Taylor Inst. Cos.**

GAGES, Mercury
- **Amthor Testing Mach.**
- Bacharach Industrial Inst.
- **Bailey Meter Co.**
- **Builders-Providence**
- Central Scientific
- Connelly Iron Sponge
- Defender Automatic Reg.
- Dubrovin, John
- Dwyer Mfg. Co.
- **Eimer & Amend**
- Gas Appliance Specialties
- **Heise Bourdon Tube**
- Ideal Lab. Tool
- **King Engineering**
- Machlett & Son
- Manning, Maxwell & Moore
- **Mason-Neilan Regulator**
- **Meriam Co.**
- **Moeller Instrument**

(Cont'd)

GAGES, Mercury (Cont'd)
- **Morey & Jones**
- **Precision Therm.**
- **Refinery Supply Co.**
- **Scientific Glass Apparatus**
- **Simplex Valve & Meter**
- Specialty Glass Co.
- **Tagliabue Mfg. Co.**
- **Taylor Inst. Cos.**
- **Trerice Co.**
- **Trimount Instrument**
- **Uehling Instrument Co.**

GAGES, Micrometer
- **Ames Co., B. C.**
- **Amthor Testing Mach.**
- Axelson Mfg.
- Brown & Sharpe
- Central Scientific Co.
- Coats Mach. Tool Co.
- **Gaertner Scientific Corp.**
- Haines Gauge Co.
- Instrument Specialties Co.
- Lufkin Rule Co.
- **Millers Falls Co.**
- **Precision Therm. & Inst.**
- Scherr Co.
- **Van Keuren Co.**
- Vinco Corp.
- Zeiss, Inc., Carl

GAGES, Oil (See Gages, Liquid Level)

GAGES, Optical
- **Bausch & Lomb**
- Chicago Dial Ind. Co.
- Clark & Sons
- **Fecker, J. W.**
- **Gaertner Scientific Corp.**
- **Jarrell-Ash Co.**
- Jones & Lamson Machine
- Ruska & Co.
- Scherr Co.
- United Cinephone Corp.
- Vinco Corp.
- Zeiss, Inc., Carl

GAGES, Paint Film
- **General Elec. Co.**
- Hathaway Inst. Co.
- **Instrument Specialties Co.**
- Metron Instrument
- Munsell Color Co.
- Saxl Inst. Co.

GAGES, Paper Thickness (See Gages, Thickness)

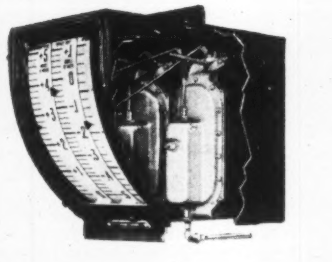
GAGES, Piston Ring
- Littelfuse Inc.
- Wilkening Mfg. Co.

TANK GAUGES
for
EVERY
REQUIREMENT
LIQUIDOMETER
EMPTY
FULL

LIQUIDOMETER remote reading gauges automatically indicate or record liquid levels. No pumps, valves or auxiliary units required to read them. Balanced hydraulic transmission system ingeniously compensates for temperature variations on communicating tubing. Accuracy unaffected by variation in specific gravity. Approved by Underwriters Laboratories and similar bodies for gauging hazardous liquids. Models are available for remote signals, automatic control of pumps, etc. DIRECT READING models available where remote reading is not required.

Write for details on LIQUIDOMETER instruments.

THE LIQUIDOMETER CORP.
36-27 SKILLMAN AVE. LONG ISLAND CITY, N. Y.



BAILEY MULTI-POINTER GAGES

● Bailey Multi-Pointer Gages are made with any number of pointers and any scale combination from one to twelve. The pointers have 10" motion over plainly marked plastic molded scales so that readings can be taken at a distance of 20 feet. Diaphragm actuated elements enable this gage to withstand over-drafts and over-pressures without injury to the unit or its calibration.

All secondary factors such as draft, pressure, temperature, stoker speed and pulverizer feed can be indicated on one Bailey Multi-Pointer Gage.

BAILEY METER COMPANY
1041 IVANHOE ROAD · CLEVELAND, O.
Bailey Meter Company Ltd., Montreal, Canada

FOX MUNITIONS CORPORATION
'ON TARGET'
Tools & Instruments
21st & ARCH ST.
PHILADELPHIA 3

SIZE CONTROL
REVERSIBLE PLUG GAGES

4636 FULTON Columbus 1117 CHICAGO 44, ILL.

STOCK—10 DAYS DELIVERY

REVERSIBLE
SIZE CONTROL
CHICAGO, ILL.

Cut Gaging Cost 50-90 Per Cent

Pin-Vise Type of Handle . . .

1. No separate inserts to break or lose.
2. Holds plug ends securely with no slippage.
3. Short, compact handle is easy to turn around in use.
4. Permits plug ends to be inserted as far in or as far out of handle as necessary to gage full lengths of hole.

Reversible Plug Ends .010" to 1.000" . . .

1. Straight pieces instead of tapered shank gives gaging surface over entire length of plug.
2. Ends can be reversed when worn, doubling their life at no extra cost.
3. Ends can be cut off, as worn, multiplying life of gage several times. Pin-vise handle readily and securely adjusts length of gage extending from handle.

Chrome Plated Reversible Gages . . .

1. Hard chrome plate gives minimum of five times the wear over unplated gages, and in the reversible design where there are two gages in one, at least ten times the wear is had over unplated AGD taperlock designs. Cuts gaging costs proportionately and does a much better gaging job since gage is not worn undersize that many times and chance of passing defective parts is greatly reduced.

Also Thread-Gear-Spline Measuring Wires in Stock

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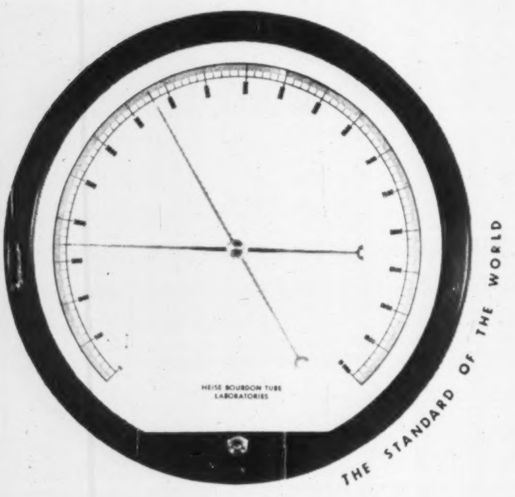
SIZE CONTROL CO.

4636 FULTON Columbus 1117 CHICAGO 44, ILL.



EVERY DAY we are shipping these precision pressure gauges to be used in place of dead weight testers. They are accurate, dependable and easy to read. Delivery—2 to 6 weeks.

RANGE FROM 0-60 lbs. to 0-10,000 lbs

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16" Dial..............	176.00

HEISE BOURDON TUBE LABORATORIES

BROOK ROAD NEWTOWN, CONNECTICUT

IN COLLABORATION WITH THE A. H. EMERY COMPANY

GAGES, Pitch Diameter
Brown & Sharpe
Detroit Tap & Tool
Federal Prod. Corp.
Greenfield Tap & Die
Lufkin Rule Co.
Pratt & Whitney
Scherr Co., Inc.
Sheffield Corp.
Size Control Co.
Union Tool Co.
Van Keuren Co.
Vinco Corp.
West & Dodge Thr. Gage

GAGES, Plug
Acme Industrial
Axelson Mfg.
Brown & Sharpe
Clark, Jr., Pneumatic
Corning Glass Works
Detroit Tap & Tool
Federal Tool Corp.
Ford Motor Co.
Fox Munitions
Greenfield Tap & Die
Lawrence & Hill
Lincoln Park Tool
Merz Engineering
Morse Twist Drill
Pratt & Whitney
Precision Gage & Tool
R & M Mfg. Co.
Saxl Instrument
Sheffield Corp.
Size Control Co.
Swedish Gage
Troy Tool & Gage
United Precision Prod.
Vinco Corp.
West & Dodge Thr. Gage
Woodworth Co.

GAGES, Pneumatic Tank
Bacharach Industrial
Mason-Neilan Regulator
Pneumercator Co.
Rochester Mfg. Co.
Star Brass
Uehling Inst. Co.

GAGES, Precision Measuring
Acme Industrial
Ames Co., B. C.
Brown & Sharpe
Carson Micrometer
Comtor Co.
Federal Prod. Corp.
Ferner Co.
Ford Motor Co.
(Cont'd)

GAGES, Precision Measuring (Cont'd)
Fox Munitions
Jansson Gage Co.
Lufkin Rule Co.
Merz Engineering
Metron Instrument
Moore Products
Pratt & Whitney
Ricker Instrument Co.
Scherr Co., Inc.
Sheffield Corp.
Size Control Co.
Starrett Co.
Swedish Gage
Thwing-Albert Inst. Co.
United Precision Prod.
Van Keuren Co.
Vinco Corp.
Carl Zeiss, Inc.

GAGES, Pressure, Indicating
Abercrombie Pump Co.
American Meter Co.
Anderson Co.
Ashton Valve Co.
Bacharach Industrial Inst.
Bailey Meter Co.
Baird Associates
Baldwin-Southwark Corp.
Bastian-Blessing
Belfield Co.
Boekel & Co.
Bristol Co.
Brown Inst. Co.
Brush Development Co.
Builders-Providence
Central Scientific Co.
Certified Gauge
Clapp Instrument
Clark Blast Meter
Consol. Ashcroft Hancock
Continental Elec. Co.
Crosby Steam Gage
Defender Automatic Reg.
Dickson Co.
Distillation Products
Dubrovin John
Edison Electrical Controls
Elmer & Amend
Electric Auto-Lite
Esterline-Angus Co.
Fisher Scientific Co.
Foxboro Co.
Fredericks, George
Friez & Sons
Gas Appliance Specialties
General Elec. Co.
Gotham Inst.
Green, Henry J.
(Cont'd)

GAGES, Pressure, Indic
ing (Cont'd)
Hays Corp.
Heise Bourdon Tube
H & H Thermostats
Kurman Electric
Logansport Machine
Marsh Corp.
Marshalltown Mfg.
Mason-Neilan Regulat
Mercoid Corp.
Meriam Co.
Metron Instrument
Moeller Instrument C
National Research
Northern Engineering
Parks Co. Harry S.
Pioneer Instrument
Pittsburgh Equitable Me
Plumb Co., Inc.
Precision Gage & Too
Precision Therm.
Preferred Utilities Mfg
Ranco Inc.
RCA Manufacturing
Refinery Supply Co.
Republic Flow Meters
Rochester Mfg. Co.
Scientific Inst. Co.
Star Brass Mfg. Co.
Stokes Machine Co.
Superior Meter Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trerice Co.
Trimount Instrument
Uehling Instrument Co
United Cinephone Cor
U. S. Gauge Co.
Victor Equipment Co
Wagner & Son Carl
Wallace & Tiernan (L
Pressure)
Welch Mfg. Co.
Wheelco Instruments
Wilgus Manufacturing

GAGES, Pressure—Recor
ing (See Gages, Pre
sure, Indicating)

GAGES, Pressure Temper
ture (See Gages, Pre
sure Indicating)

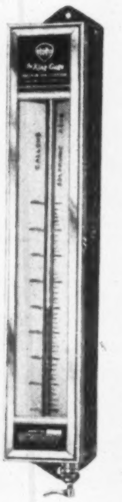
GAGES, Pressure, Tire
U. S. Gauge Co.

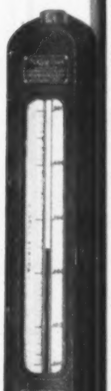
GAGES, Pressure & Va
uum (See Gages, Pre
sure Indicating)

Liquid Measuremen

with the

King - Gage





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The King-Gage is widely used in paint, chemical and food industry in place of expensive weigh-tanks. On storage tanks it gives an accurate check on receipts, inventory and consumption. Can be located nea the tank or at a distance on a central control panel. Writ our Engineering Department for information on any o your liquid measuring problems. Seventeen years of ex perience and engineering representatives in fourteen o the largest cities are all at your service.

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7000
8000
9000
10000

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Proven in Peace . . . now Tested in the Turmoil of War, the Clapp Acragage has already proven itself in the exclusive top-flight circle of all precision-built, indicating pressure gages. Today we are looking forward to the Post-War Period, and we would like the privilege of joining your planning conference so that we may work out for you exactly the gage you need to completely solve your gage problems in the strenuous days of adjustment lying before us. The proven superior principles of the Acragage can be applied to a model that will fulfill your every requirement, whether it be a special case or dial, corrosion or vibration, or any other special condition.

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WEBSTER, MASS.

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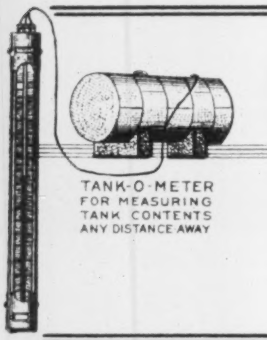
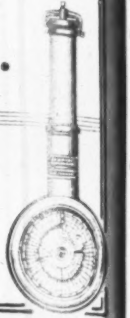
WEBSTER
MASS

PRESSURE GAGES

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FOR MEASURING
TANK CONTENTS
ANY DISTANCE AWAY

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Vacuum-Draft-CO₂
Absolute Pressure Recorders - Liquid Level Gauges
473 GETTY AVENUE
PATERSON, N. J.

GAGES, Profile
- **Fox Munitions**
- Jansson Gage Co.
- Lincoln Park Tool
- Merz Engineering
- **Pratt & Whitney**
- **Precision Gage & Tool**
- R & M Mfg. Co.
- Sheffield Corp.
- Stockton Profile Gauge
- Swedish Gage Co.
- United Cinephone Corp.
- Vinco Corp.

GAGES, Radius
- **Lufkin Rule Co.**
- Starrett Co.
- Swedish Gage Co.
- United Cinephone Corp.
- Vinco Corp.

GAGES, Rain (See Rain Gages)

GAGES, Rifle Bore
- Baldwin Southwark
- **Fox Munitions**
- Hathaway Inst. Co.
- Poole Mfg. Engrs.
- **Pratt & Whitney**
- Sheffield Corp.
- **Size Control Co.**
- Vinco Corp.

GAGES, Ring
- Acme Industrial
- Axelson Mfg.
- **Brown & Sharpe**
- Corning Glass Works
- Detroit Tap & Tool
- **Fox Munitions**
- **Greenfield Tap & Die**
- Lawrence & Hill
- Lincoln Park Tool
- Merz Engineering
- **Morse Twist Drill**
- **Pratt & Whitney**
- **Precision Gage & Tool**
- R & M Mfg. Co.
- Saxl Instrument
- **Sheffield Corp.**
- Swedish Gage Co.
- Troy Tool & Gage
- Vinco Corp.
- **West & Dodge Thread**
- Woodworth Co.
- Zeiss, Inc., Carl

GAGES, Screw Thread
- Acme Industrial
- Axelson Mfg.
- **Brown & Sharpe**
- Clark, Jr. Pneumatic Tool
- Detroit Tap & Tool
- **Federal Prod. Corp.**
- **Fox Munitions**
- **Greenfield Tap & Die**
- Jansson Gage Co.
- Lincoln Park Tool
- **Lufkin Rule Co.**
- Merz Engineering
- Millers Falls Co.
- **Pratt & Whitney**
- **Reed Small Tool Works**
- Sheffield Corp.
- **Size Control Co.**
- **Starrett Co.**
- **Union Tool Co.**
- Vinco Corp.
- **West & Dodge Thread**
- Woodworth Co.
- Zeiss, Inc., Carl

GAGES, Sliding
- **Pratt & Whitney**
- **Van Keuren Co.**

GAGES, Snap
- **Brown & Sharpe**
- Clark, Jr. Pneumatic Tool
- Detroit Tap & Tool
- **Fox Munitions**
- Gen. Engg. & Model Wks.
- **Greenfield Tap & Die**
- Jansson Gage Co.
- Lawrence & Hill
- Lincoln Park Tool
- Merz Engineering
- **M-G Gage Corp.**
- **Pratt & Whitney**
- **Precision Gage & Tool**
- R & M Mfg. Co.
- Scherr Co.
- Sheffield Corp.
- Troy Tool & Gage
- Vinco Corp.

GAGES, Spline
- **Brown & Sharpe**
- **Fox Munitions**
- Merz Engineering
- **Pratt & Whitney**
- **Precision Gage & Tool**
- **Sheffield Corp.**
- **Size Control Co.**
- Vinco Corp.

GAGES, Star
- Moore Products
- Pratt & Whitney

GAGES, Strain
- **American Inst. Co.**
- Baldwin-Southwark
- **Consolidated Engg.**
- General Elec. Co.
- Hathaway Inst. Co.
- Metron Instrument
- **Metzger & Son**
- **Miller Corp., Wm.**
- **Olsen Testing Machine**
- **Pratt & Whitney**
- **Saxl Inst. Co.**
- **Starrett Co.**
- **Waugh Laboratories**

GAGES, Surface
- **Ames Co., B. C.**
- **Brown & Sharpe**
- **Federal Prod. Corp.**
- **Fox Munitions**
- **Genales, Andrew**
- Jansson Gage Co.
- **Lufkin Rule Co.**
- **Millers Falls Co.**
- **Saxl Inst. Co.**
- **Starrett Co.**
- Vinco Corp.
- Zeiss, Inc., Carl

GAGES, Taper
- **Brown & Sharpe**
- **Federal Prod. Corp.**
- **Fox Munitions**
- **Lincoln Park Tool**
- Merz Engineering
- Micro Master Co.
- **Precision Gage & Tool**
- **Pratt & Whitney**
- R & M Mfg. Co.
- **Sheffield Corp.**
- **Starrett Co.**
- **United Precision Prod.**
- Vinco Corp.

GAGES, Telescoping
- **Brown & Sharpe**
- **Lufkin Rule Co.**
- Pacific Tool & Supply
- **Starrett Co.**

GAGES, Thickness
- **Ames Co., B. C.**
- **Amthor Testing Inst. Co.**
- **Brown & Sharpe**
- **Commercial Research**
- **Federal Prod. Corp.**
- **Ford Motor Co.**
- **Fox Munitions**
- **General Elec. Co.**
- **Gen. Engg. & Model Wks.**
- **Hathaway Inst. Co.**
- **Ill. Testing Labs.**
- **Instrument Specialties Co.**
- **Lawrence & Hill**
- **Lufkin Rule Co.**
- **Magnetic Gauge Co.**
- **Marshall Co.**
- Merz Engineering
- **Metzger & Son**
- **Millers Falls Co.**
- **Moore Products**
- **Pratt & Whitney**
- **Precision Gage & Tool**
- **Precision Therm. & Inst.**
- **Randall, Frank E.**
- **R & M Mfg. Co.**
- **Saxl Inst. Co.**
- **Sheffield Corp.**
- **Speidel & Co.**
- **Starrett Co.**
- **Suter, Alfred**
- **Thwing-Albert Inst. Co.**
- **Union Tool Co.**
- **Van Keuren Co.**
- Vinco Corp.
- **Waltham Dial Gage**

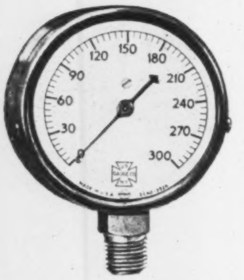
GAGES, Thickness, Magnetic
- **American Inst. Co.**
- **Commercial Research**
- **General Elec. Co.**
- **Hathaway Inst. Co.**
- **Hickok Elec. Inst. Co.**
- **Magnetic Gauge Co.**
- Metron Instrument

GAGES, Tide
- **American Inst. Co.**
- **Ballauf Mfg. Co.**
- **Uehling Instrument Co.**

GAGES, Torque
- Apco Mossberg Co.
- Baldwin Southwark
- **Martin Decker Corp.**
- Metron Instrument
- **Riehle Div.**
- **Saxl Inst. Co.**
- **Sturtevant Co.**
- **Toledo Scale Co.**

GAGES, Vacuum (See Gages, Pressure)

GAGES, Venturi (See Flow Meters, Venturi)



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ACCURATE.

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PRESSURE GAUGES

● Marsh Pressure Gauges are known for accuracy and their ability to stay accurate. Pressure gauges in all standard ranges up to 30,000 pounds—also vacuum, altitude, compound and recording gauges. An outstanding feature is the "Recalibrator"—far superior to the ordinary "zero" adjustment. The latest addition to the Marsh line is the new Marsh "Mastergauge" series—gauges tremendously advanced in accuracy and stamina.

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GAGES, Water Level (See Gages, Liquid Level)

GAGES, Wind
American Inst. Co.
Detroit Air Meter
Friez & Sons
Fuess, Inc.
Green, Henry J.
Kenyon Instrument Co.
Rieker Inst. Co.
Taylor Inst. Cos.

GAGES, Wire Measuring
Ames Co., B. C.
Brown & Sharpe
Federal Prod. Corp.
Greenfield Tap & Die
Hathaway Inst. Co.
Instrument Specialties Co.
Merz Engineering
Moore Products
Pratt & Whitney
Sheffield Corp.
Size Control Co.
Starrett Co.

GAGING FIXTURES
Fox Munitions
Herkimer Tool
Lawrence & Hill
Merz Engineering
Ryan Tool & Engg.
Saxl Instrument
Swedish Gage
Vinco Corp.

GALVANOMETERS, A-c.
Associated Research
Brush Development Co.
Cambridge Inst. Co.
Central Scientific Co.
Cole Instrument
Consolidated Engg.
General Elec. Co.
Hathaway Inst. Co.
Heiland Research Corp.
Leeds & Northrup Co.
Metron Instrument
Pfaltz & Bauer, Inc.
Rawson Electrical Inst.
RCA Manufacturing
Rubicon Co.
Sensitive Research Inst.
Tagliabue Mfg. Co.
Welch Mfg. Co.
Weston Elec. Inst.
Wheelco Inst. Co.

GALVANOMETERS, Astatic
Cambridge Inst. Co.
Central Scientific Co.
Chicago Apparatus Co.
Hathaway Inst. Co.
Leeds & Northrup Co.
(Cont'd)

GALVANOMETERS, Astatic (Cont'd)
Rawson Electrical Inst.
Sensitive Research Inst.
Westinghouse Elec. & Mfg.
Wheelco Inst. Co.

GALVANOMETERS, D-c.
Associated Research
Brown Inst. Co.
Cambridge Inst. Co.
Central Scientific Co.
Chicago Apparatus Co.
Cole Instrument
Consolidated Engg.
De Jur-Amsco
Electro-Tec Div.
General Elec. Co.
G-M Labs.
Hathaway Inst. Co.
Heiland Research
Hickok Elect. Inst. Co.
J-B-T Instruments
Leeds & Northrup Co.
Metals Research App.
Metron Instrument
Pfaltz & Bauer, Inc.
Rawson Electrical Inst.
RCA Manufacturing Co.
Roller-Smith Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Simpson Elec. Co.
Tagliabue Mfg. Co.
Thwing-Albert Inst.
Triplett Electrical Inst.
Welch Mfg. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
Wheelco Inst. Co.

GALVANOMETERS, Piezoelectric
Brush Development Co.

GALVANOMETERS, Reflecting
Associated Research
Consolidated Engg.
Heiland Research
Rawson Electrical Inst.
Rubicon Co.
Ruska & Co.

GALVANOMETERS, Vacuum-tube
Engineering Labs., Inc.
Hathaway Instrument Co.
Heiland Research
Measurements Corp.
Metals Research App.
National Technical Labs.
RCA Manufacturing
Tagliabue Mfg. Co., C. J.

GALVANOSCOPES
Central Scientific Co.

GAS ANALYZERS, Air
Burrell Technical Supply
Cambridge Inst. Co.
Central Scientific Co.
Eimer & Amend
Fish-Schurman Co.
Fisher Scientific Co.
Friez & Sons
Hebler Co.
Mercoid Corp.
Mine Safety Appliances
Permutit Co.
Sargent & Co.
Scientific Glass App.
Tagliabue Mfg. Co.
Willson Products, Inc.

GAS ANALYZERS, Ammonia
Burrell Technical Supply
Cambridge Inst. Co.
Engelhard, Chas.
Mercoid Corp.
Permutit Co.
Sargent & Co.
Tagliabue Mfg. Co.

GAS ANALYZERS, Carbon Dioxide
Ace Glass Inc.
Bacharach Industrial Inst.
Brown Inst. Co.
Burrell Tech. Supply
Cambridge Inst. Co.
Central Scientific Co.
Defender Automatic Reg.
Dwyer Mfg. Co.
Eimer & Amend
Ellison Draft Gage Co.
Engelhard, Chas.
Fish-Schurman Co.
Fisher Scientific Co.
Friez & Sons
Gow-Mac Instrument
Hays Corp.
Hebler Co.
Lantz-Phelps Corp.
Leeds & Northrup Co.
Machlett & Son
Permutit Co.
Potter Co.
Precision Therm.
Preferred Utilities Mfg.
Republic Flow Meters
Sargent & Co.
Scientific Glass App.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Uehling Instrument Co.
Williams Apparatus Co.

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BY USING THE
PRACTICAL
FYRITE
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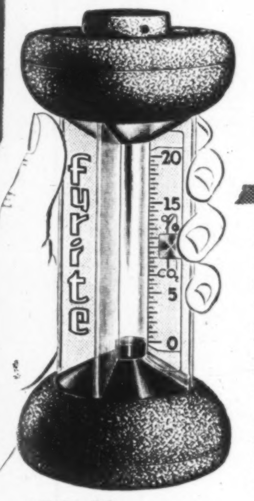

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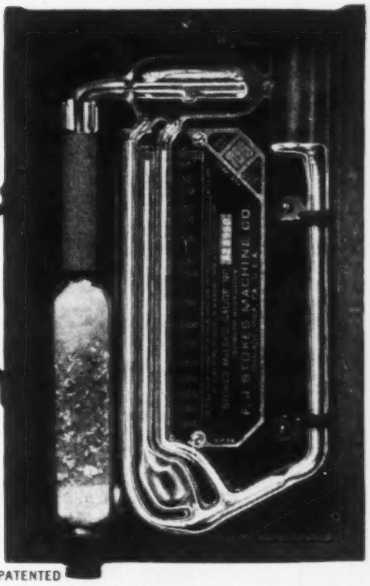

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This new, improved Stokes Portable (McLeod type) Vacuum Gauge provides rapid (2 to 5 seconds) readings within the micron range with permanent accuracy under all conditions. It does not require calibration against other gauges and retains its accuracy in the presence of all gases including hydrogen, and condensable vapors including water and oil.

These gauges are compact, rugged, convenient to use as portable instruments or on fixed mountings. Applicable in all vacuum operations within the micron and 5 mm. ranges.

These instruments are widely used in physics, organic and physical chemistry laboratories and by Industry . . . for applications such as drying blood plasma, penicillin and biologicals from the frozen state, organic distillation under higher vacuum than heretofore (in which ordinary closed-end manometers are not adequate) and for testing efficiencies of vacuum methods, apparatus and systems.

New Bulletin No. 42-G describes these improved instruments, their many uses, contains specifications, prices, etc.

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. . . Also adaptable for determining purity of

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COMPACT AND PORTABLE, the new Model 120-A **CAMBRIDGE EXHAUST GAS TESTER** is a precision instrument designed for testing internal combustion engines. By analysis of the exhaust gas, it continuously indicates the precombustion air-fuel ratio of the mixture supplied to the engine. This new gas analyzer is not only accurate, but it is sufficiently rugged to meet the exacting demands of military service. The instrument case (7⅛"x6½"x9") is robust, dust-proof and essentially waterproof. Although designed primarily for automotive work, this portable instrument may be modified to analyze other gases, determining their purity, etc., etc.

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3732 Grand Central Terminal, N. Y. C. 17

GAS ANALYZERS, Carbon Monoxide
- Bacharach Industrial Inst.
- **Burrell Technical Supply**
- **Cambridge Inst. Co.**
- Chicago Apparatus Co.
- Eclipse Aviation
- **Eimer & Amend**
- **Fish-Schurman Co.**
- **Hays Corp.**
- **Leeds & Northrup Co.**
- Machlett & Son
- **Mine Safety Appliances**
- Sargent & Co.
- Scientific Glass App.
- Scientific Inst. Co.
- **Tagliabue Mfg. Co.**

GAS ANALYZERS, Chlorinated Hydrocarbons
- Willson Products, Inc.

GAS ANALYZERS, Flue Gas (See Gas Analyzers, Carbon Dioxide)

GAS ANALYZERS, Hydrocarbon
- **Consolidated Eng.**

GAS ANALYZERS, Hydrogen
- Bacharach Industrial Inst.
- **Burrell Technical Supply**
- Chicago Apparatus Co.

GAS ANALYZERS, Hydrogen Sulphide
- **American Meter**
- **Burrell Technical Supply**
- Bushnell & Nevins
- **Cambridge Inst. Co.**
- **Connelly Iron Sponge**
- Davis Emergency Equip.

(Cont'd)

GAS ANALYZERS, Hydrogen Sulphide (Cont'd)
- **Eimer & Amend**
- Johnson-Williams, Ltd.
- Mine Safety Appliances
- **Rubicon Co.**
- Sargent & Co.
- Scientific Glass Apparatus

GAS ANALYZERS, Nitric Oxide
- **Cambridge Inst. Co.**
- **Eimer & Amend**
- **Rubicon Co.**
- **Sargent & Co.**

GAS ANALYZERS, Orsat
- Ace Glass Inc.
- **Bailey Meter Co.**
- **Burrell Technical Supply**
- Central Scientific Co.
- Chicago Apparatus Co.
- Defender Automatic Reg.
- Dwyer Mfg. Co.
- **Eimer & Amend**
- Ellison Draft Gage
- **Fish-Schurman Co.**
- Fisher Scientific Co.
- **Hays Corp.**
- Machlett & Son
- **Precision Therm.**
- Sargent & Co.
- Scientific Glass App.
- Specialty Glass Co.

GAS ANALYZERS, Oxygen
- **Burrell Technical Supply**
- Chicago Apparatus Co.
- **Cambridge Inst. Co.**
- Eclipse Aviation
- **Eimer & Amend**
- **Hays Corp.**
- Hebler Co.
- **Mine Safety Appliances**
- Sargent & Co.
- Scientific Glass App.
- **Tagliabue Mfg. Co.**

GAS ANALYZERS, Oxygen & Nitrogen Apparatus
- Boekel & Co.
- **Burrell Technical Supply**
- **Cambridge Inst. Co.**
- Central Scientific Co.
- **Eimer & Amend**
- Hebler Co.
- Sargent & Co.
- **Tagliabue Mfg. Co.**

GAS ANALYZERS, Sulphur Dioxide
- Bacharach Industrial Inst.
- Bushnell & Nevins
- **Cambridge Inst. Co.**
- **Eimer & Amend**
- Engelhard, Chas.
- **Fish-Schurman Co.**
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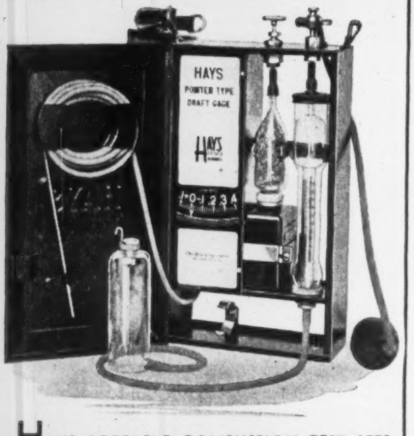

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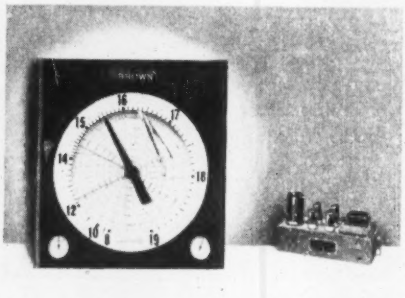

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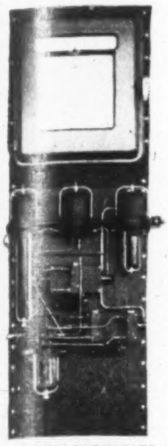

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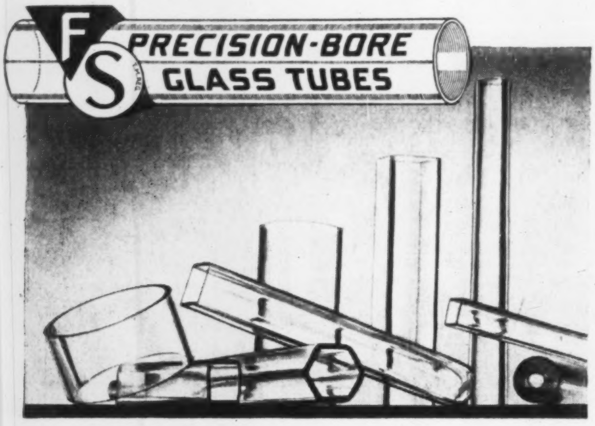

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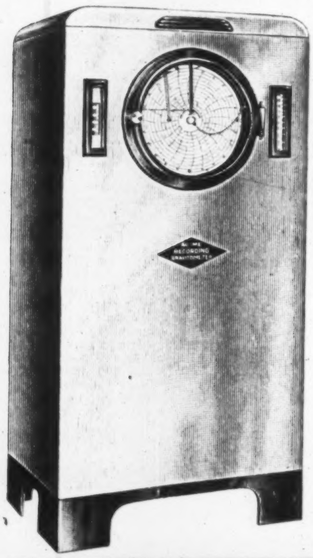

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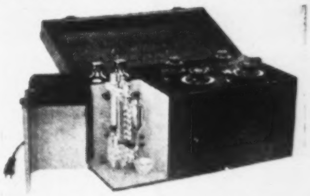

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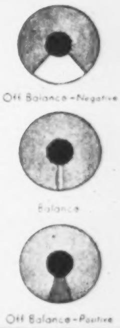

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Kollsman Instrument

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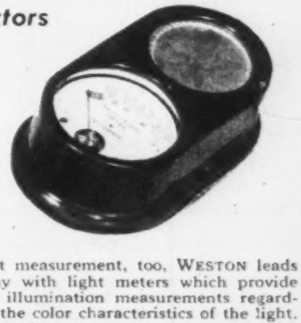

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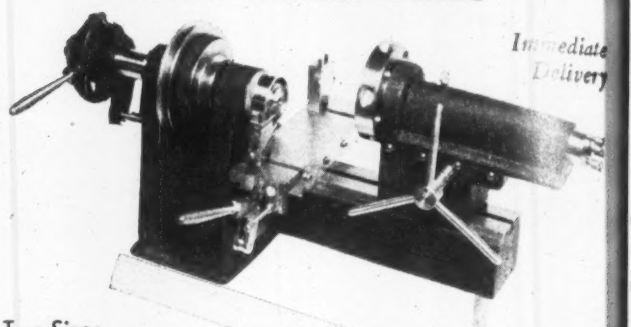

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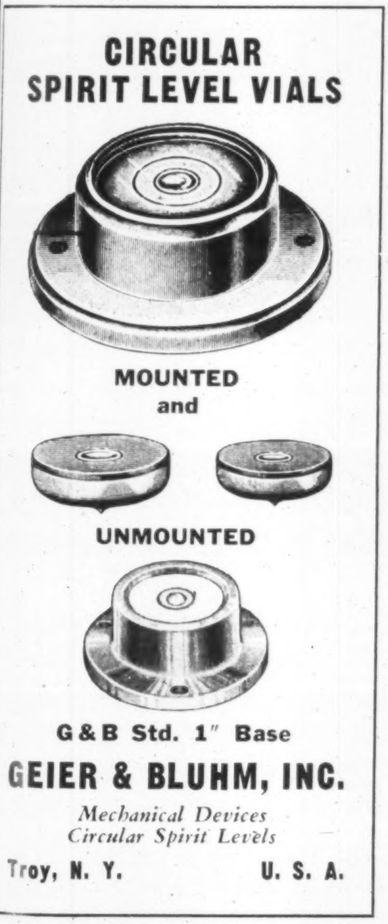

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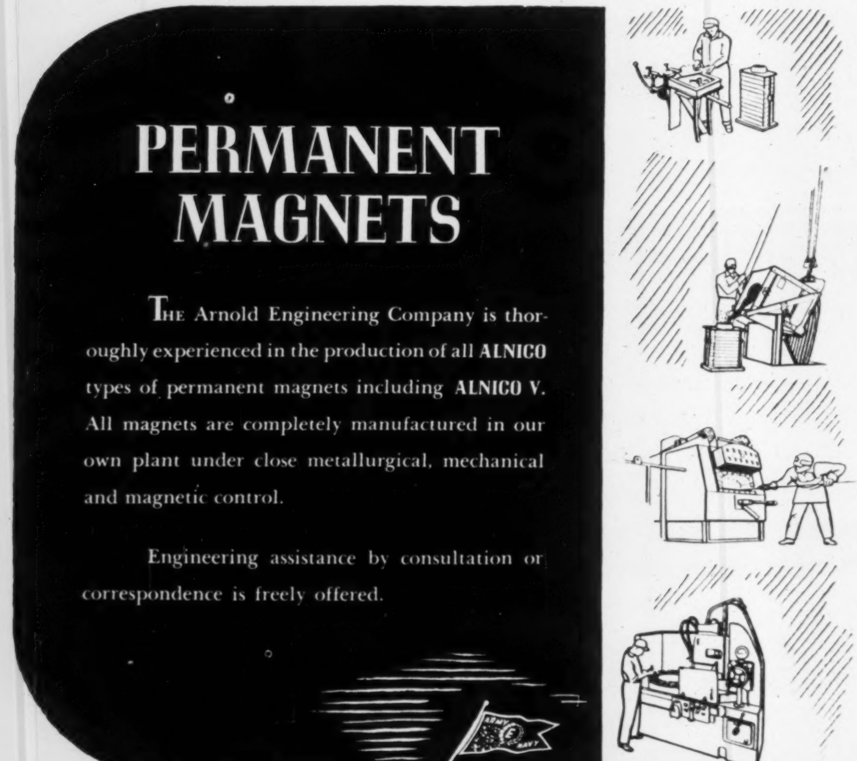
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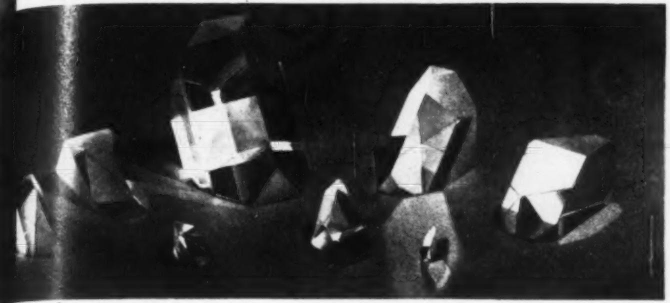

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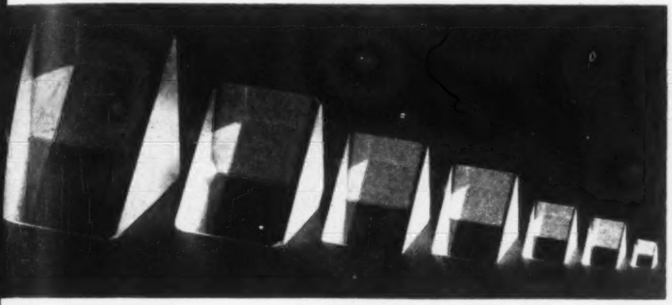

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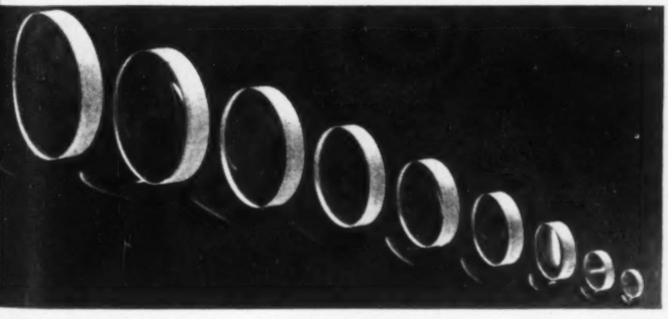

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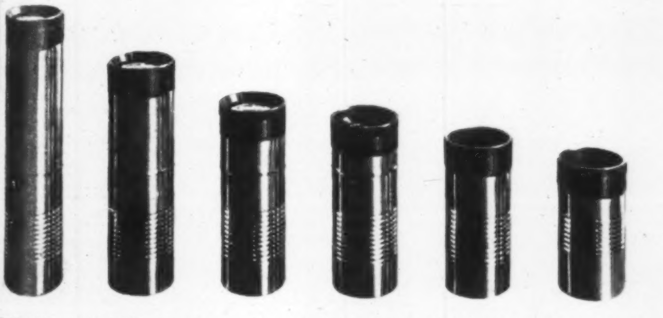

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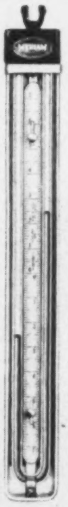

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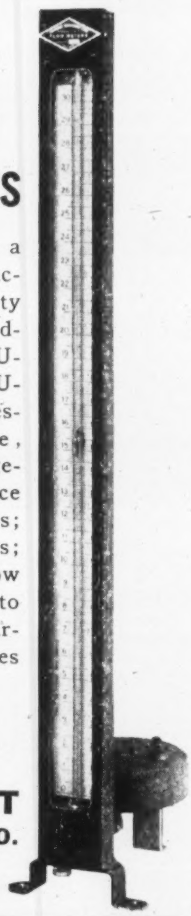

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Lambert Meter Co., Inc.
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Builders-Providence
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Keuffel & Esser Co.
Leupold & Stevens
Mason-Neilan Regulator
National Meter Co.
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Pgh. Equitable Meter Co.
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Brown Inst. Co.
Builders-Providence
Fischer & Porter
Foxboro Co.
Lambert Meter Co.
Mason-Neilan Regulator
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Taylor Inst Cos.

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Lambert Meter Co.
Precision Scientific
Superior Meter Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.

METERS, Gas, Station
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Bowser & Co.
Pgh. Equitable Meter Co.

METERS, Gasoline (See Meters, Liquid)

METERS, High Pressure & High Pressure Distribution
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Pgh. Equitable Meter Co.
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Neptune Meter Co.
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Brodie Co., Inc.
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Sparling, R. W.

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Ralph N. Brodie Co., Inc.
Pgh. Equitable Meter
Ruska & Co., Inc.
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Bowser & Co., Inc.
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Ohmer Register
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METERS, Multi-Rate
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METERS, Orifice (See Flowmeters, Orifice)

METERS, Oxygen (See 1—Gas Analyzer; 2—Gas Meters)

METERS, Pitot Tube (See Flowmeters, Pitot Tube)

METERS, Positive Displacement (See Gas Meters, Positive and Liquid Meters, Volumetric)

METERS, Prepayment
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Landis & Gyr, Inc.

METERS, Proportional
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Bristol Co.
Fischer & Porter
Foxboro Co.
Mason-Neilan Regulator
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Thompson Clock Co.
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Warren Telechron Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

METERS, Ultraviolet Radiation
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Westinghouse Elec. & Mfg.

METERS, Venturi (See Flowmeters, Venturi)

METERS, V-notch (See Flowmeters, Weir)

METERS, Volumetric, Positive Displacement (See Gas Meters, Positive; see Meters, Liquid, Volumetric)

METERS, Water (See Liquid Meters, Volumetric; also Flowmeters, Liquid)

METERS, Watt-Hour
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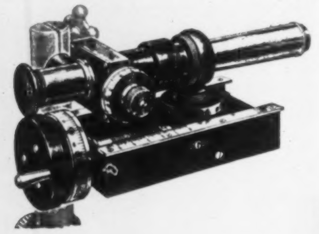

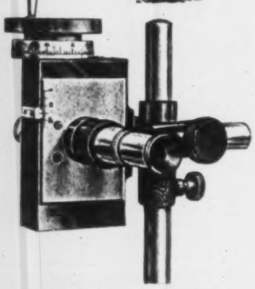
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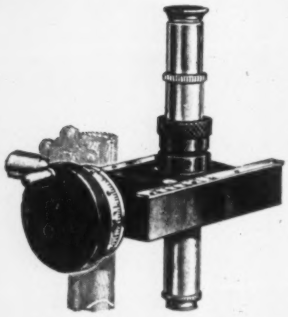
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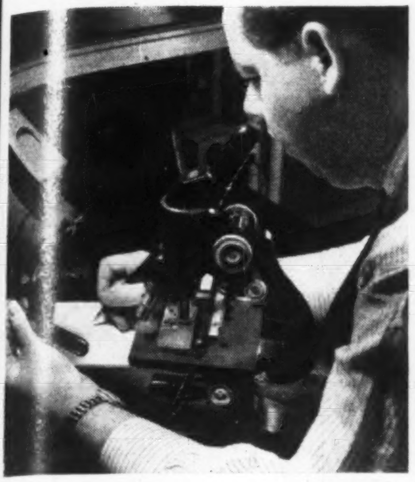

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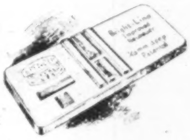

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MICROVOLTMETERS (See Voltmeters, Micro)

MILEAGE METERS (See Meters, Mileage)

MILITARY INSTRUMENTS (See Ordnance Instruments)

MILK TESTERS (See Testers, Milk)

MILLIAMMETERS (See Ammeters, Milliammeters)

MILLIOHMMETERS (See Ohmmeters, Milliohmmeters)

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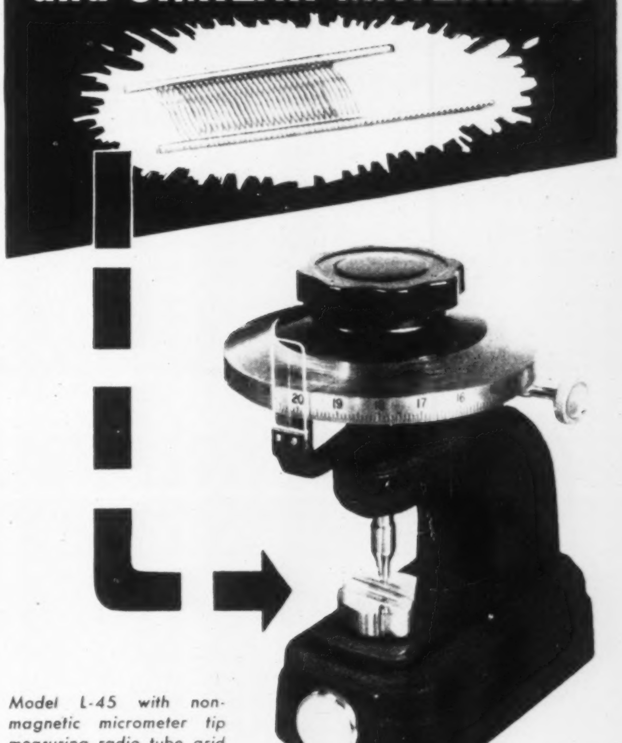
Measuring Dimensions of RADIO TUBE GRIDS, CATHODES, ASSEMBLIES, and SIMILAR MATERIALS



Model L-45 with non-magnetic micrometer tip measuring radio tube grid diameter.

THE CARSON ELECTRONIC MICROMETER MEASURES ACCURATELY TO .00005"

The simplicity of operation of this super sensitive (to .00005") Electronic Micrometer makes it possible for any operator to measure dimensions of radio tube grids, etc., and to repeat thickness readings on these and other materials which cannot be measured accurately by "conventional" measuring instruments.

Work is placed on lower anvil under micrometer tip and dial rotated until micrometer contacts the work as indicated by bull's eye in the base. Dial gives final correct reading independent of "feel" — Dial divisions for every .0001" (.00005" for model L-45), each thousandth numbered. Reads like a hand micrometer.

Three models available
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The entire unit with attractive mahogany carrying case weighs but 20 lbs., requires no leveling or calibration, and operates from any 110 volt 60 cycle circuit. Write today for further information.

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CAMBRIDGE HAND MODEL MOISTURE INDICATOR, when exposed to the air, measures its Relative Humidity. This instrument quickly indicates moisture content of various hygroscopic materials such as **PAPER, TEXTILES, GRAIN, ETC.** It can be calibrated with two scales, one showing percent Relative Humidity and the other percent water. With the **pistol grip** instrument (illustrated) the Relative Humidity of atmosphere, or moisture Content of materials into which the blade is inserted, may be promptly determined. **Indispensible for checking, if moisture content in a material is specified.**

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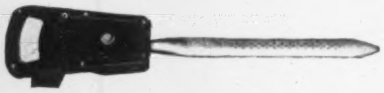

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see page 126

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MOTORS, Fractional H.P.
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Barber-Coleman Co.
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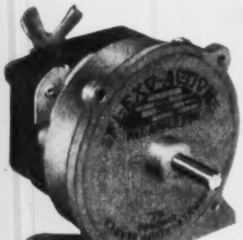

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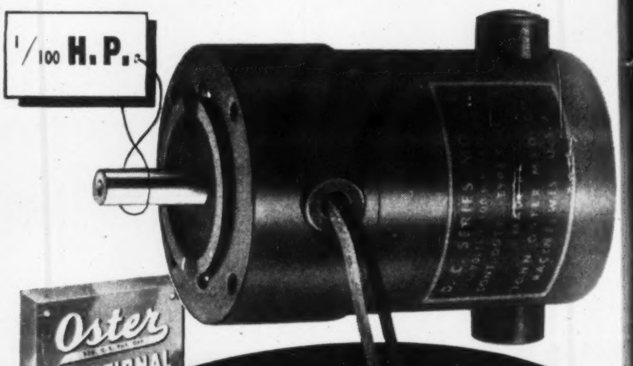

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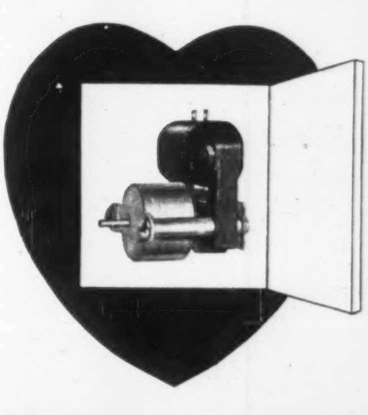

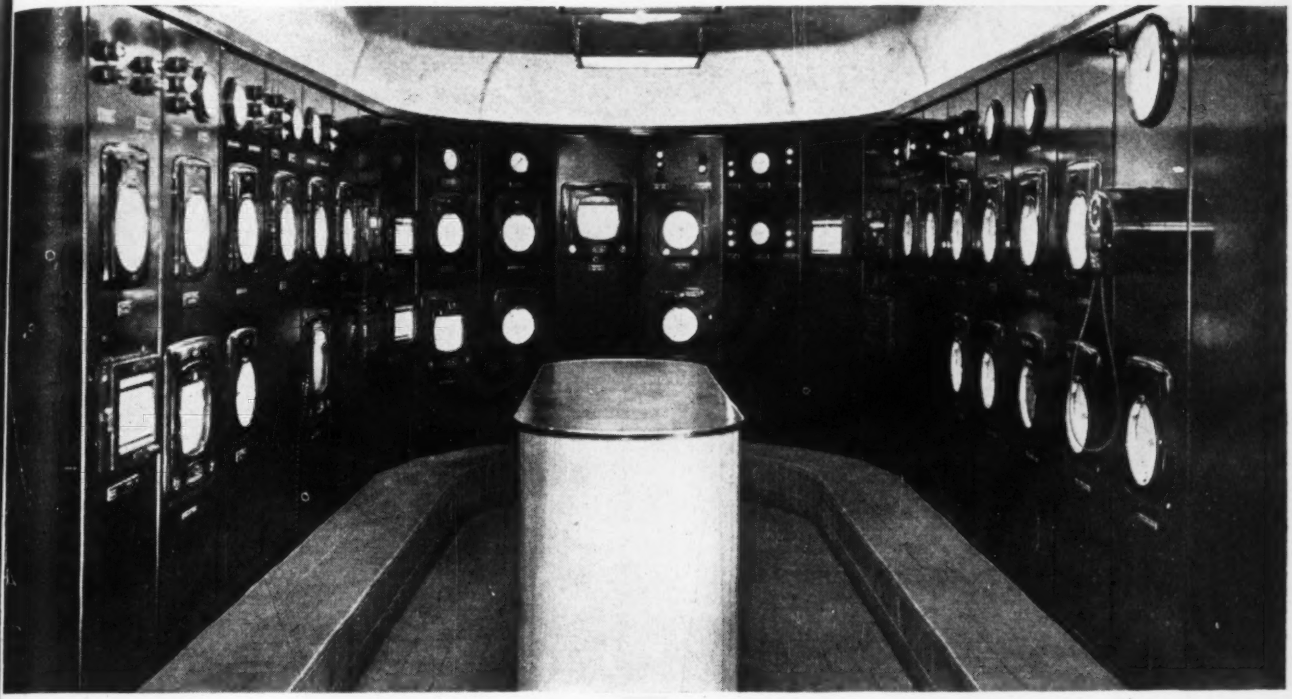

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These instruments accurately control temperature, pressure, flow, liquid levels and gases, and other processes. *And back of every round-chart instrument is a sturdy, synchronous Telechron motor.*

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- Maxwell Smith Co.
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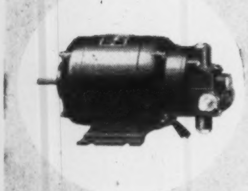
for important instrument applications



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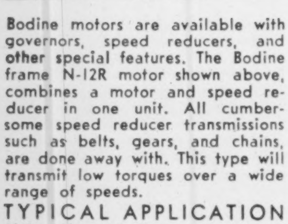

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OPTICAL FILTERS (See Filters, Optical)

OPTICAL FLATS (See Flats, Optical)

OPTICAL MICROMETERS (See Micrometers, Optical)

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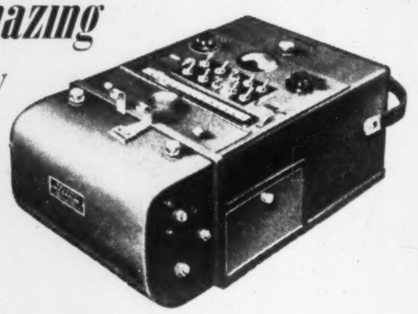

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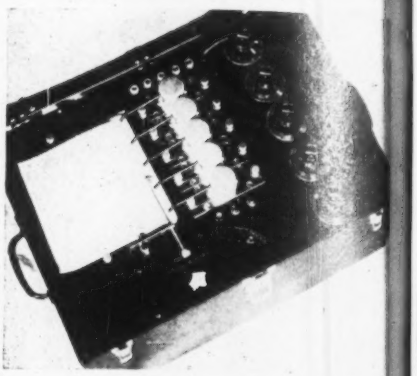

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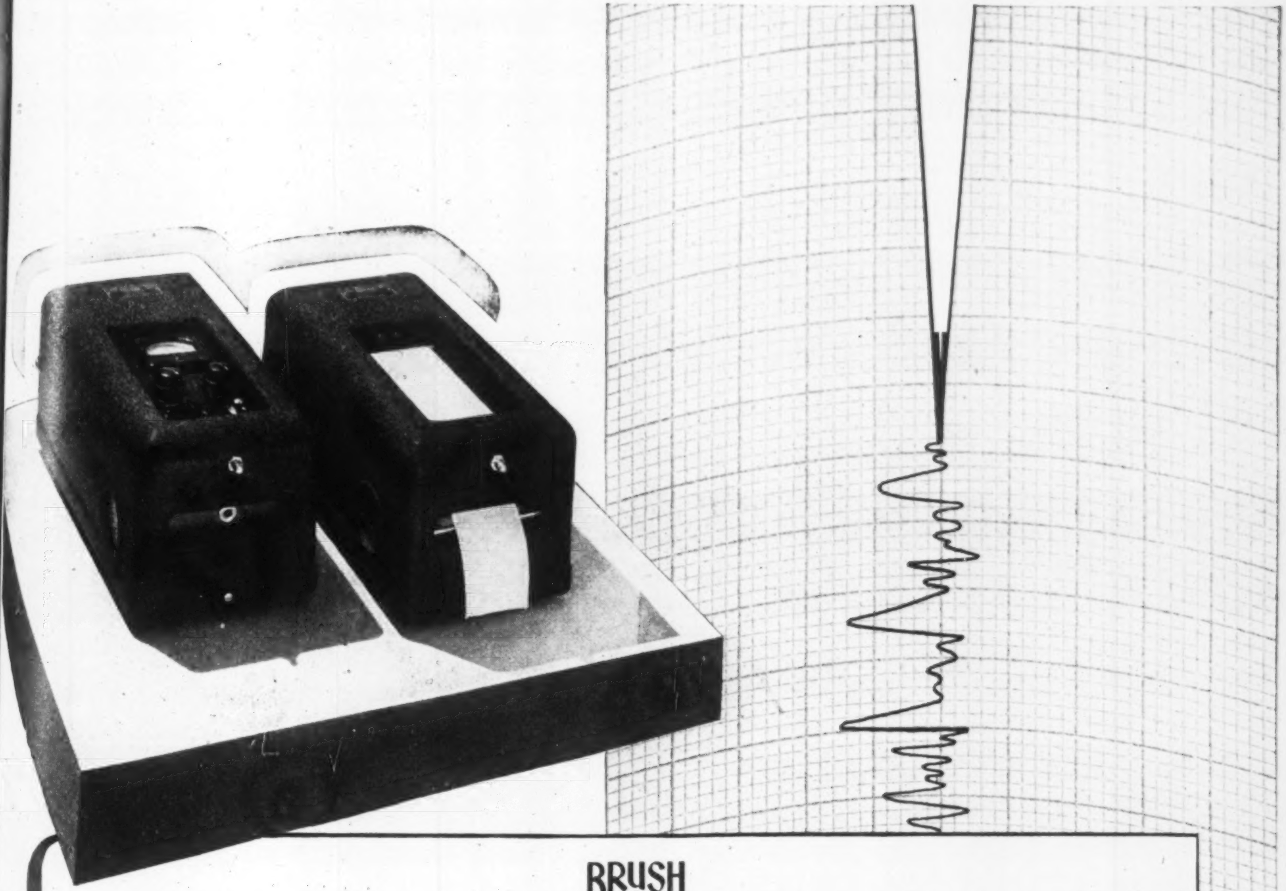

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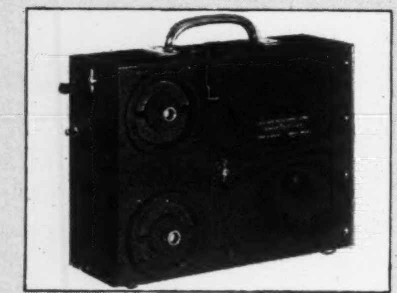

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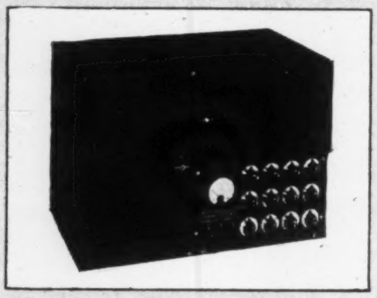

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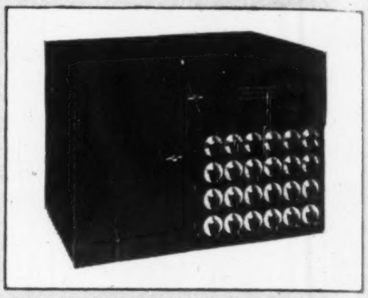

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During the last two years a definite reversal of trend in the development of meters for rate of flow measurement has become noticeable in industry. The area-type flow meter, in the form of the rotameter sight flow meter, has steadily and surely elbowed its way to the front. Already it has completely replaced the head-type meters (orifices, flow nozzles, venturis, weirs, capillaries) for many important applications and the process of replacement is still going on.

In Toricelli's equation $Q=CA\sqrt{2gh}$, the area-type meter (rotameter) obtains measurement by varying the value of "A" (area of flow passage) whereas head meters vary the value of "h" (head producing flow). Thus the rotameter "gets out from under the square root sign," and has a linear calibration scale instead of a square root scale crowded at the lower end. The range of flows which can be accurately metered with the rotameter is thereby tremendously increased.

Furthermore, the visibility in the rotameter of the fluid being metered and of the metering elements eliminates errors due to fouling or corrosion. Likewise, the pressure drop through the rotameter is low and constant because the flow area enlarges as the float rises in the tapered tube with flow increase. The further one delves into the details the more advantages come to light. Send for Bulletin 10-B . . . it's crammed full of easily understood demonstrations of the rotameter's superiority, presented in an absorbing, whimsical way. There is no obligation for this, of course.

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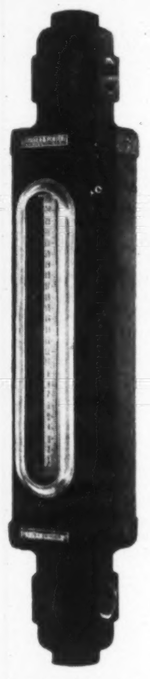

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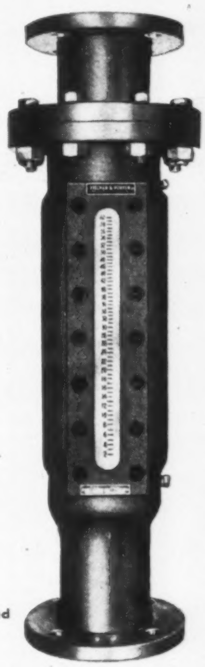
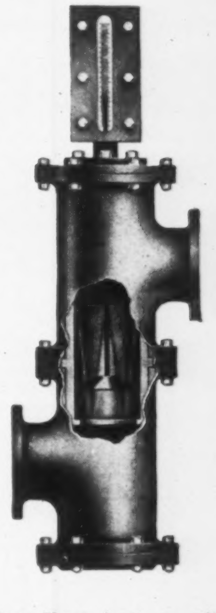


Figure 22 Armored Rotameter

The amazing, new ROTA-SLEEVE for LARGE flows



The Rota-Sleeve (patent applied for) is a new type of area flow meter designed to measure large flows accurately at a reasonable cost. The sleeve, shown in the cut-away view, is made with V-port flutes to give increasing flow measuring area as the float rises. The Rota-Sleeve fits into standard pipe tees and is made in all large sizes from 3" up. It can be direct-indicating as shown in the illustration, or remote-reading in either recording or recording-controlling forms. The Rota-Sleeve has all the advantages of the rotameter area meter, such as high accuracy, straight line calibration, wide flow range, low pressure loss, and *instantaneous* response to flow changes. Write for complete information.

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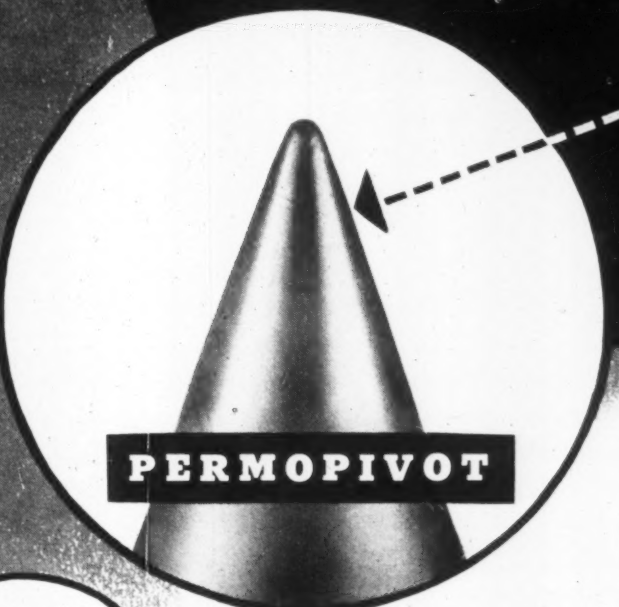
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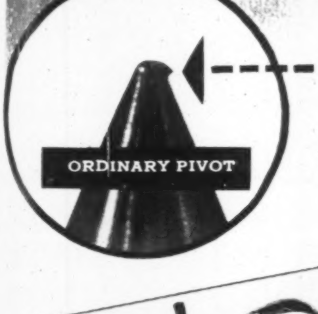
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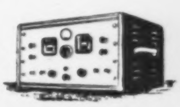

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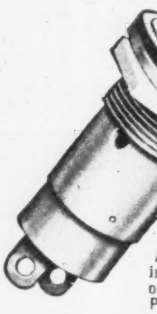

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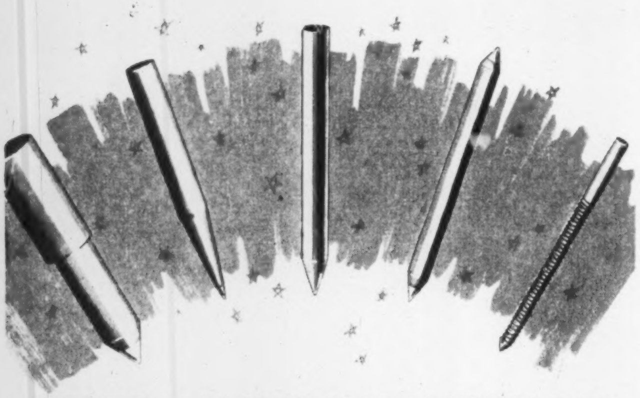

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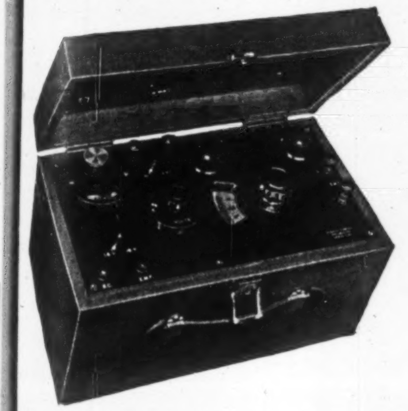

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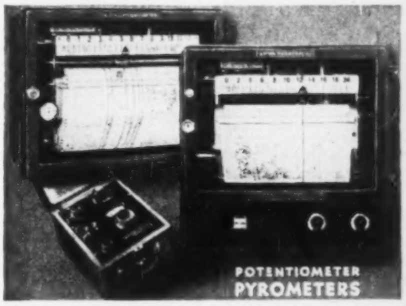

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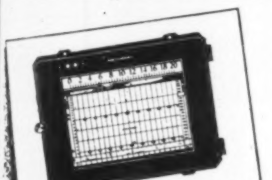

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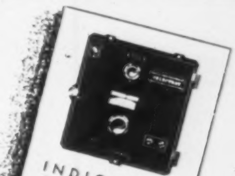

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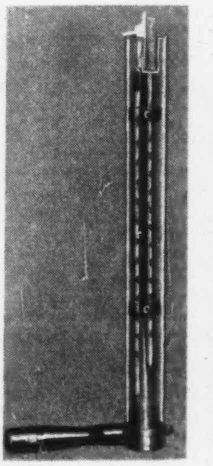

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- Am. Gas Furnace Co.
- Bristol Co.
- Brown Inst. Co.
- Cambridge Inst. Co.
- Cole Instrument

(Cont'd)

PYROMETERS, Millivoltmetric (Cont'd)
- De Jur-Amsco Corp.
- Elematic Sales Corp.
- Engelhard, Chas.
- Foxboro Co.
- Hoskins Mfg. Co.
- Ill. Testing Labs.
- Pyrometer Instrument Co.
- Roller-Smith Co.
- Rubicon Co.
- Taylor Inst. Cos.
- Thwing-Albert Instrument
- Wheelco Inst. Co.

PYROMETERS, Optical
- Bacharach Indus. Inst.
- Brown Inst. Co.
- Burrell Technical Supply
- Cambridge Inst. Co.

(Cont'd)

PYROMETERS, Optical (Cont'd)
- Fisher Scientific Co.
- Leeds & Northrup Co.
- Pyrometer Instrument Co.

PYROMETERS, Portable
- Bacharach Indus. Inst.
- Bristol Co.
- Brown Inst. Co.
- Burrell Technical Supply
- Cambridge Inst. Co.
- Cole Instrument
- De Jur-Amsco
- Elematic Sales Corp.
- Engelhard, Chas.
- Foxboro Co.
- Hoskins Mfg. Co.
- Ill. Testing Labs.
- J-B-T Instruments

(Cont'd)

PYROMETERS, Portable (Cont'd)
- Leeds & Northrup Co.
- Lewis Engg. Co.
- Pyrometer Instrument Co.
- Rubicon Co.
- Tagliabue Mfg. Co.
- Thwing-Albert Instrument
- Wheelco Inst. Co.

PYROMETERS, Potentiometric
- Bailey Meter Co.
- Bristol Co.
- Brown Inst. Co.
- Cambridge Inst. Co.
- De Jur-Amsco
- Dickson Co.
- Foxboro Co.
- J-B-T Insts., Inc.

(Cont'd)

PYROMETERS, Potentiometric (Cont'd)
- Leeds & Northrup Co.
- Lewis Engg. Co.
- Rubicon Co.
- Tagliabue Mfg. Co.
- Thwing-Albert Instrument
- Wheelco Inst. Co.

PYROMETERS, Radiation, Controlling
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- Bacharach Indust. Inst.
- Bailey Meter Co.
- Bristol Co.
- Brown Inst. Co.
- Cambridge Inst. Co.
- Engelhard, Chas.
- Foxboro Co.

(Cont'd)

PYROMETERS, Radiation, Controlling (Cont'd)
- General Elec. Co.
- Ill. Testing Labs.
- Leeds & Northrup Co.
- Thwing-Albert Instrument
- Wheelco Inst. Co.

PYROMETERS, Radiation, Indicating
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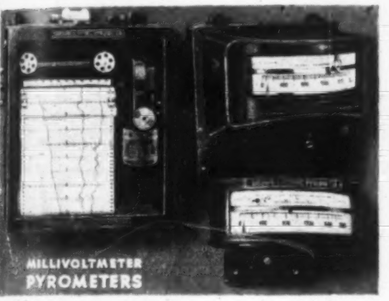
- Bristol Co.
- Brown Inst. Co.
- Cambridge Inst. Co.
- General Elec. Co.
- Leeds & Northrup Co.
- Pyrometer Instrument Co.
- Thwing-Albert Instrument
- Wheelco Inst. Co.



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MINNEAPOLIS-HONEYWELL CONTROL SYSTEMS
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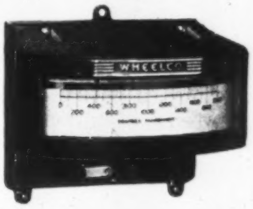
Temperature Measuring Instruments



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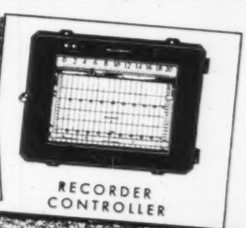

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More Accurate Temperature Record

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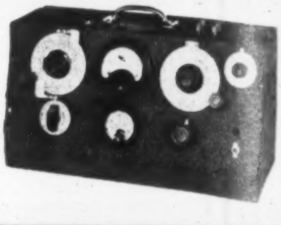
Q-METER

TYPE 160-A



Frequency Range: 50kc. to 75mc. may be extended with external oscillator down to 1 kc.
Range of Q Measurements, Coils: 50 to 625.
Accuracy: In general ± 5%
Range of Q Tuning Condenser: 30-450 mmf. (Vernier Condenser: ± 3 mmf.)

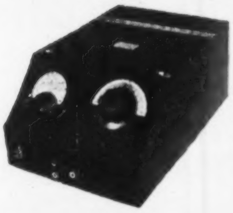
Q-METER

TYPE 170-A

Frequency Range: 30mc. to 200 mc.
Range of Q Measurements, Coils: 100-1200
Accuracy: In general ± 10%
Range of Q Tuning Condenser: 10-60 mmf.

QX CHECKER

TYPE 110-A



The factory counterpart of the Q-Meter. Compares fundamental characteristics of inductance or capacitance and Q under production line conditions with a high degree of accuracy, yet quickly and simply. Insures uniform parts held within close tolerances. Frequency range 100 kc. to 25 mc.

FREQUENCY MODULATED SIGNAL GENERATOR

TYPE 150 SERIES

Type 150 A—Frequency 41-50 mc. and 1-10 mc.
Type 151 A—Frequency 30-40 mc. and 1-9 mc.
Type 152 A—Frequency 20-28 mc. and 0.5-5 mc.
Type 154 A—Frequency 27-39 mc. and 1-7 mc.
Developed specifically for use in design of F.M. equipment. Frequency and Amplitude Modulation available separately or simultaneously.

BEAT FREQUENCY GENERATOR

TYPE 140-A

A single compact instrument which provides wide frequency and voltage coverage of generated signals.
Frequency Range: 20 cycles to 5 mc. in two frequency ranges.
Output Voltage Range: 1 millivolt to 32 volts.
Accuracy: ± 3%.
Output Power: One watt into external load.

BOONTON RADIO *Corporation* BOONTON, NEW JERSEY

YROMETERS, Radiation, Recording
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Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
General Elec. Co.
Leeds & Northrup Co.
Pyrometer Instrument Co.
Thwing-Albert Instrument

YROMETERS, Thermoelectric, Immersion
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
De Jur-Amsco
Elematic Sales Corp.
General Elec. Co.
Ill. Testing Labs.
J-B-T Insts., Inc.
Leeds & Northrup Co.
Lewis Engg. Co.
Partlow Corp.
Pyrometer Inst. Co.
Roller-Smith Co.
Tagliabue Mfg. Co.
Thwing-Albert Instrument
Wheelco Instruments
Woermann-Schuchhardt

YROMETERS, Thermoelectric, Indicating
Am. Gas Furnace Co.
Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
Cole Instrument
De Jur-Amsco Corp.
Elematic Sales Corp.
Foxboro Co.
Hobler Co.
Hoskins Mfg. Co.
Ill. Testing Labs.
J-B-T Insts., Inc.
Leeds & Northrup Co.
Lewis Engg. Co.
Partlow Corp.
Pyrometer Instrument Co.
Roller-Smith Co.
Rubicon Co.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Thwing-Albert Instrument
Western Instrument Co.
Wheelco Inst. Co.

PYROMETERS, Thermoelectric, Recording & Controlling
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Bailey Meter Co.
Beck Co.
Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
Engelhard, Chas.
Foxboro Co.
General Elec. Co.
Ill. Testing Labs.
Leeds & Northrup
Lewis Engg. Co.
Mason-Neilan Regulator
Partlow Corp.
Pyrometer Instrument Co.
Tagliabue Mfg. Co.
Thwing-Albert Instrument

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Bristol Co.
Cambridge Inst. Co.
Elematic Sales Corp.
Foxboro Co.
General Elec. Co.
Ill. Testing Labs.
J-B-T Instruments
Lewis Engg. Co.
Pyrometer Instrument Co.
Schweitzer & Conrad
Tagliabue Mfg. Co.
Thwing-Albert Instrument
Wheelco Instruments

PYROMETRIC CONES
(See Cones, Pyrometric)

Q METERS
Boonton Radio

QUARTZ, Fused Quartz Apparatus
Hanovia Chem. & Mfg.
Thermal Syndicate Ltd.

RACKS, STEEL, For Capacitors, Resistors, Transformers, etc.
Falstrom Co.

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Canadian Radium
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Andrew, Victor J.
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- Even standard "Coprox" mountings are very adaptable.

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"Coprox" BX-22.3
Double bridge rectifier with current and temperature-current characteristics balanced to better than 1% over a range of −40°C to +70°C. Rated up to 4.5 volts A.C., 3 volts D.C., 5 milliamperes D.C.

"Coprox" BX-100
Center tap, full wave rectifier. Completely enclosed in Bakelite. Low capacitance. Rectifies high frequency current. Rated up to 4.5 volts A.C., 3.0 volts D.C., 500 microamperes D.C.

"Coprox" BX-22.5
Single half-wave rectifier rated up to 4.5 volts A.C., 3.0 volts D.C., 2.5 milliamperes D.C.

"Coprox" BX-22.2
Full wave rectifier rated up to 4.5 volts A.C., 3.0 volts D.C., 5 milliamperes D.C.

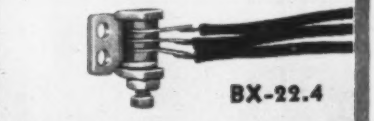
"Coprox" BX-22.4
Double half-wave rectifier rated up to 4.5 volts A.C., 3.0 volts D.C., 2.5 milliamperes D.C.

BX-22.3

BX-100

BX-22.5

BX-22.2


BX-22.4

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Cole-Instrument
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General Elec. Co.
Hickok Elec. Inst. Co.
Lampkin Laboratories
Measurement Corp.
Millen Mfg. Co.
Premier Crystal Labs.
Rawson Electrical Inst.
RCA Manufacturing Co.
Roller-Smith Co.
Sensitive Research Inst.
Simpson Elec. Co.
Triplett Electrical Inst.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

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RADIO-MICROMETERS (See Micrometers, Radio)

RADIO REMOTE CONTROL SYSTEMS
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McFarlin Co.
Metron Instrument
Pioneer Instrument
United Cinephone Corp.
Wallace & Tiernan

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RADIOSONDES
Wallace & Tiernan

RADIO TEST PANELS (See Panels, Radio Test)

RADIO TUBE CHECKERS (See Checkers, Radio Tube)

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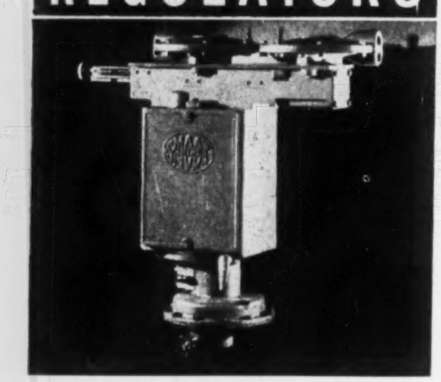
Central Scientific Co.
Friez & Sons
Fuess, Inc.
Green, Henry J.
Gurley, W. & L. E.
Keuffel & Esser Co.
Leupold & Stevens
Precision Therm.
Stewart, M. C.
Taylor Inst. Cos.
Warren-Knight Co.
White Co., Inc.

RAINFALL RECORDERS
Esterline-Angus Co.
Friez & Sons
Fuess, Inc.
Green, Henry J.
Leupold & Stevens
Taylor Inst. Cos.



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Republic-Smoot regulators are supplied for the automatic control of pressure, rate of flow, speed of rotation, level of a liquid or the proportioning of two pressures, flows, etc., in a fixed ratio by mechanically operating a valve, damper, rheostat or various types of variable speed transmissions.

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Gaertner Scientific Corp.
Kern Co.
Keuffel & Esser Co.
Kollmorgen Optical Co.
Leitz, Inc.
Precision Therm.
RCA Manufacturing
Stafford Co.
White Co., Inc.

RANGE POLES (See Surveying Instruments)

REACTANCE METERS
Andrew, Victor J.
General Radio Co.
Premier Crystal Labs.
RCA Manufacturing
Rubicon Co.

REACTIVE VOLT-AMPERE METERS, see Volt-ampere Meters, Reactive

READING LENSES, Thermometer & Burette (See Lenses, Reading)

RECORDERS (See object of measurement and control)

RECTIFIERS, Dry Disc
Am. Automatic Electric
Benwood Linze Co.
Birtcher Corp.
Bradley Labs.
Control Corp.
Dearborn Scientific
Elec. Facilities, Inc.
General Elec. Co.
Mallory & Co.
Mellaphone Corp.
Raytheon Mfg. Co.
Standard Elec. Time
United Transformer Corp.

RECTIFIERS, Power
Amer. Automatic Elec. (Max.—5 amps.)
Applied Research Labs.
Benwood Linze
Birtcher Corp.
Bradley Labs.
Dayton Acme Co.
Eclipse Aviation
Elec. Facilities, Inc.
Electro Products Labs.
General Elec. Co.
Mellaphone Corp.
Raytheon Mfg. Co.
RCA Manufacturing
United Transformer Corp.

RECTIFIERS, Thermionic
American Automatic Elec.
Amplifier Co.
Andrew, Victor J.
Benwood Linze
Bertcher Corp.
Communication Meas. Lab.
Continental Elec. Co.
Dearborn Scientific
DuMont Labs., Inc., A.B.
Electro Products Labs.
Electrons, Inc.
Emby Products
General Elec. Co.
Hy-Ef Elec. Products
Mellaphone Corp.
Raytheon Mfg. Co.
RCA Manufacturing Co.
United Cinephone Corp.
United Transformer Corp.

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Bacharach Indust. Inst.
Crosby Steam Gage Co.
Robertson, 3rd, J. L.
Trill Indicator Co.

REFLECTIONMETERS (See Reflectometer)

REFLECTOMETERS
Akatos, Inc.
American Inst. Co.
Dearborn Scientific
Higgins, Charles F.
Leeds & Northrup Co.
Pfaltz & Bauer
Photovolt Corp.

REFLECTORS, Aspherical
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.

REFLECTORS, Concave
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Buhl Optical
Clark & Sons
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.
Tinsley Labs.

REFLECTORS, First Surface
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Buhl Optical
Clark & Sons
Dearborn Scientific
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.
Tinsley Labs.
Zenith Optical

REFLECTORS, Heat Resisting
Am. Telescope Labs.
Bausch & Lomb Optical
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.

REFLECTORS, Parabolic
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Clark & Sons
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.
Tinsley Labs.
Weber Bros. Metal Works

REFLECTORS, Spherical
Am. Telescope Labs.
Baird Associates
Bausch & Lomb Optical
Buhl Optical
Clark & Sons
Fecker, J. W.
Fish-Schurman Co.
Fuess, Inc.
Perkin-Elmer Corp.
Tinsley Labs.

REFLECTORS, Stellite
American Telescope Labs.
Bausch & Lomb Optical
Fecker, J. W.
Kollmorgen Optical Co.
Perkin-Elmer Corp.

REFRACTOMETERS
Akatos, Inc.
Bausch & Lomb Optical
Central Scientific Co.
Dearborn Scientific
Fish-Schurman Corp.
Fuess, Inc.
Gaertner Scientific
Jarrell-Ash Co.
Spencer Lens Co.
Zeiss, Inc., Carl

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Coors Porcelain Co.

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Arca Regulators, Inc.
Askania Regulator Co.
Bailey Meter Co.
Bastian-Blessing Co.
Belfield Co.
Boekel & Co.
Boylston Co.
Bristol Co.
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Brown Inst. Co.
Cash Co.
Connelly Iron Sponge
Cutler-Hammer, Inc.
Davis Reg. Co.
D'Este Co.

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Foster Engg. Co.
Foxboro Co.
Friez & Sons
Hagan Corp.
Johnson Service Co.
Judson Governor Co.
Kiely & Mueller
Lammert & Mann Co.
Leslie Co.
Linde Air Products Co.
Manning, Maxwell & Moore
Mason Neilan Regulator
McAlear Mfg. Co.
McCorkle Co.
Mercon Regulator Co.
Moore Products
National Airoil Burner
Natural Gas Equipment
Northern Equip. Co.
Parks-Cramer Co.
Partlow Corp.
Payne Furnace & Supply
Penn Electric Switch Co.
Pgh. Equitable Meter
Powers Regulator Co.
Preferred Utilities Mfg.
Republic Flow Meters
Reynolds Gas Regulator
Robertshaw Thermostat
Ruggles-Klingemann
Schade Valve Mfg.
Sprague Meter Co.
United Cinephone Corp.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Valverde Labs.
Vaughn-G.E. Witt Co.
Victor Equipment Co.
Watts Regulator Co.
White-Rodgers Electric
Wilgus Mfg. Co.

REGULATORS, AUTOMATIC, Atmospheric
Foxboro Co.
Mason-Neilan Regulator
Parks-Cramer Co.
Powers Regulator Co.
Robertshaw Thermostat

REGULATORS, AUTOMATIC, Boiler
A-Jacks Automatic
Askania Regulator Co.
Bailey Meter Co.
Brooke Eng. Co.
Brown Inst. Co.
Cash Co.
Connelly Iron Sponge
Fisher Governor Co.
Foster Engg. Co.
Foxboro Co.
General Regulator Corp.
Hagan Corp.
Hays Corp.
Hanlon-Waters, Inc.
Mason-Neilan Regulator
McAlear Mfg. Co.
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Minneapolis-Honeywell
National Brass Co.
Natural Gas Equipment
Penn Electric Switch
Perfex Corp.
Republic Flow Meters
Robertshaw Thermostat
Ruggles-Klingemann
Tagliabue Mfg. Co.
Wilgus Mfg. Co.

REGULATORS, AUTOMATIC, Compressed Gas
American Meter Co.
Bailey Meter Co.
Bastian-Blessing
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
Cash Co.
Electrimatic Corp.
Fisher Governor Co.
Frick Co.
Hanlon-Waters, Inc.
Hoke, Inc.
Mason-Neilan Regulator
McAlear Mfg. Co.
Mercon Regulator Co.

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REGULATORS, AUTOMATIC, Compressed Gas (Cont'd)
Natural Gas Equipment
Pgh. Equitable Meter
Republic Flow Meters
Reynolds Gas Regulator
Robertshaw Thermostat
Tagliabue Mfg. Co.
Victor Equipment Co.

REGULATORS, AUTOMATIC, Condensation (See Controllers, Automatic, Condensation)

REGULATORS, AUTOMATIC, Consistency (Paper & Pulp) (See Controllers, Automatic, Consistency)

REGULATORS, AUTOMATIC, Current
Amperite Corp.
Amplifier Co.
Beck Bros.
Betts & Betts
Burlington Inst. Corp.
Cutler-Hammer, Inc.
General Elec. Co.
Monitor Controller Co.
Robertshaw Thermostat
Roller-Smith Co.
Wheelco Instruments

REGULATORS, AUTOMATIC, Damper (See Controllers, Automatic, Damper)

REGULATORS, AUTOMATIC, District (See Governors, District)

REGULATORS, AUTOMATIC, Draft (See Controllers, Automatic, Draft)

REGULATORS, AUTOMATIC, Drying Chamber
Powers Regulator Co.
United Cinephone Corp.

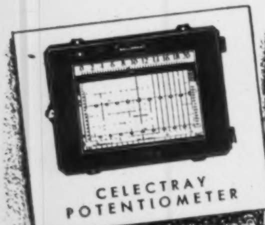
REGULATORS, AUTOMATIC, Feed Water
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Belfield Co.
Brown Inst. Co.
Cochrane Corp.
Davis Reg. Co.
Defender Automatic Reg.
General Regulator Corp.
Hagan Corp.
Hanlon-Waters, Inc.
Mason-Neilan Regulator
McAlear Mfg. Co.
McDonnell & Miller
Mercon Regulator Co.
Minneapolis-Honeywell
Natural Gas Equipment
Northern Equip. Co.
Ruggles-Klingemann
Tagliabue Mfg. Co.
Vaughn-G. E. Witt Co.
Watts Regulator Co.
Wheelco Instruments
Wilgus Mfg. Co.
Williams Gauge Co.

REGULATORS, AUTOMATIC, Flow (See Controllers, Automatic, Flow)

REGULATORS, AUTOMATIC, Flow Proportioning (See Controllers, Automatic, Flow Proportioning)

REGULATORS, AUTOMATIC, Fluid Proportioning (See Controllers, Automatic, Fluid Proportioning)

REGULATORS, AUTOMATIC, Frequency
Burlington Inst. Corp.
General Elec. Co.
Leeds & Northrup
Warren Telechron Co.
Wheelco Inst. Co.



CELECTRAY POTENTIOMETER

TAG CONTROLLING

TAG THERMOMETER

TAG RECORDERS

There is an instrument included in this group that is designed to record all temperatures from minus 200° C. up, and all industrial pressures.

Ask for catalogs . . . they graphically suggest the usefulness of Celectray Recording Potentiometer Pyrometer, TAG Recording Thermometer and Recording Pressure Gages for service and economy in your plant.

C. J. TAGLIABUE MFG. CO.
Park & Nostrand Avenues, Brooklyn 5, N. Y.

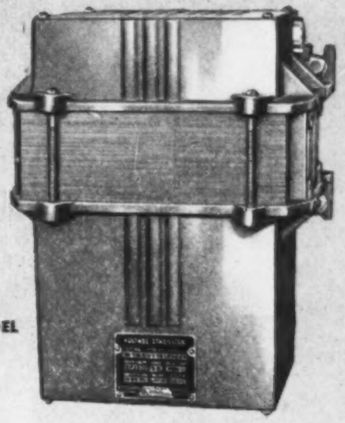
LOOK INSIDE the COVER (Part 1) ***For a* COMPLETE LIST *of* TAG INSTRUMENTS** TAG

RAYTHEON VOLTAGE STABILIZERS

control fluctuating voltage to ±½%

- Stabilize at any load within their ratings.
- Hold constant varying A. C. input voltage to ± ½%.
- Quick action . . . fluctuating input voltage is stabilized within 2 cycles. Variations cannot be observed on an ordinary volt meter.
- Wide A.C. input voltage limits . . . 95 to 130 volts.
- Entirely automatic . . . no moving parts . . . requires no maintenance . . . connect it and forget it.

Bulletin DL48-537 is new — write for your copy.



ENDBELL MODEL

DIMENSIONS IN INCHES

Index Ref. No.	L		W	H
	50~	60~		
G-5	13 1/8	12 1/2	9 5/8	8 1/2
G-6	14 5/8	14	14 3/4	11 7/8
G-7	17 1/2	16 3/8	14 3/4	11 7/8

INPUT 95-130 V 60 CYCLES 1-PHASE OUTPUT 115 V PLUS OR MINUS ½%

WATTS	CASED		Index Ref. No.	UNCASED	
	Cat. No.	Net Wt.		Cat. No.	Net Wt.
30	VR-1	8 lbs.	G-1	VR-107	6 lbs.
30	VR-1-A†	8 "	G-1	VR-107-A†	6 "
60	VR-2	18 "	G-2	VR-207	16 "
120	VR-3	26 "	G-3	VR-307	22 "
250	VR-4	46 "	G-4	VR-407	36 "
500	VR-5	70 "	G-5		
1000	VR-6	140 "	G-6		
2000	VR-7	200 "	G-7		

†OUTPUT 6.0 or 7.5 VOLTS PLUS OR MINUS ½%.

INPUT 190-260 V 60 CYCLES 1-PHASE OUTPUT 220 230 V ± ½%

WATTS	CASED		Index Ref. No.
	Cat. No.	Net. Wt.	
2000	VR-7-A	200 lbs.	G-7

INPUT 95-130 V 50 CYCLES 1-PHASE OUTPUT 115 V PLUS OR MINUS ½%

WATTS	CASED		Index Ref. No.	UNCASED	
	Cat. No.	Net Wt.		Cat. No.	Net Wt.
25	VR-155	8 lbs.	G-1	VR-158	6 lbs.
60	VR-255	21 "	G-2	VR-258	19 "
120	VR-355	26 "	G-3	VR-358	23 "
250	VR-455	50 "	G-4	VR-458	42 "
500	VR-555	80 "	G-5		
1000	VR-655	150 "	G-6		
2000	VR-755	220 "	G-7		

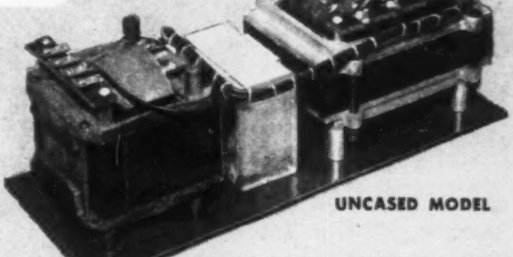
INPUT 190-260 V 50 CYCLES 1-PHASE OUTPUT 220 230 V ± ½%

WATTS	CASED		Index Ref. No.	UNCASED	
	Cat. No.	Net Wt.		Cat. No.	Net Wt.
25	VR-521	8 lbs.	G-1	VR-510	6 lbs.
60	VR-522	21 "	G-2	VR-520	19 "
120	VR-523	26 "	G-3	VR-530	23 "
250	VR-524	50 "	G-4	VR-540	42 "
500	VR-525	80 "	G-5		
1000	VR-526	150 "	G-6		
2000	VR-527	220 "	G-7		

CASED MODEL

DIMENSIONS IN INCHES

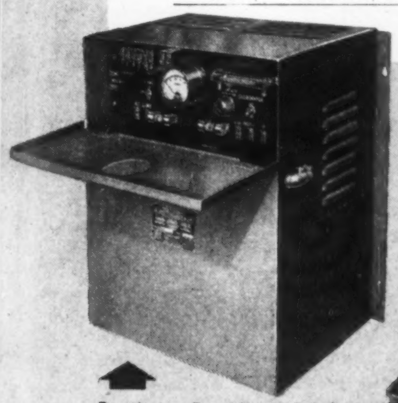
Index Ref. No.	L	W	H
G-1	8 7/8	3 7/16	4 1/2
G-2	11 3/8	5 7/8	5 5/8
G-3	15	6	6 1/8
G-4	18 5/8	7	8 7/8



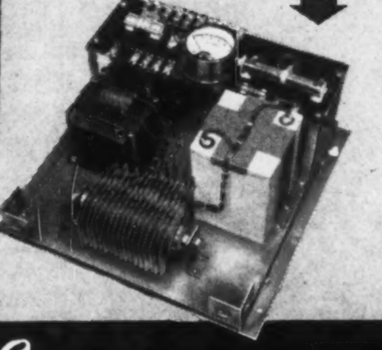
UNCASED MODEL

DIMENSIONS IN INCHES

Index Ref. No.	L	W	H Max.
G-1	7 9/16	3	3 5/8
G-2	7 7/8	5 11/16	5 3/16
G-3	12 7/32	5 11/16	5 3/8
G-4	15 9/16	6 3/4	7



Raytheon RectiChargeRs (battery chargers) . . . complete range of units from 1 to 12 amps . . . many models for 50 cycles input.

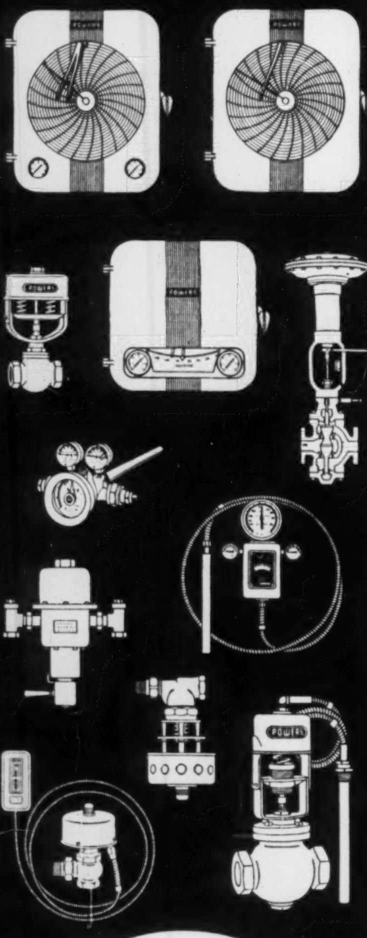


Raytheon RectiFilteRs (battery eliminators) . . . wide range of models available for varied operations . . . 50 or 60 cycles.

The coveted Army-Navy "E", for Excellence in the manufacture of war equipment and tubes, flies over all four Raytheon Plants where over 12,000 men and women are producing for VICTORY.

RAYTHEON MANUFACTURING Company

190 WILLOW ST WALTHAM, MASS



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TEMPERATURE and HUMIDITY
CONTROL

When you want accurate and dependable automatic temperature or humidity control for Industrial Processes, Heating or Air Conditioning Systems, call in a Powers engineer. With over 50 years of experience and a very complete line of self-operating and air operated controls we are well equipped to fill your requirements.

Write for Circular 2520
2734 Greenview Ave., Chicago
Offices in 47 Cities—See your phone directory.

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REGULATORS, AUTOMATIC, Humidity (See Controllers, Automatic, Humidity)

REGULATORS, AUTOMATIC, Liquid Level (See Controllers, Automatic, Liquid Level)

REGULATORS, AUTOMATIC, Load
Allis-Chalmers Mfg. Co.
Autom'c Valve Controller
Hays Corp.
Leeds & Northrup Co.
Taylor Inst. Cos.

REGULATORS, AUTOMATIC, Oil Feed
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Atlas Valve Co.
Brown Inst. Co.
Cash Co.
D'Este Co.
Fisher Governor
Foster Engg. Co.
General Regulator Corp.
Hagan Corp.
Lammert & Mann Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
McCorkle Co.
National Airoil Burner
Republic Flow Meters
Spence Engineering Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
United Cinephone Corp.
Vaughn-G. E. Witt Co.
Wilgus Manufacturing

REGULATORS, AUTOMATIC, Phase
Kollsman Instrument

REGULATORS, AUTOMATIC, Power Factor
Allis-Chalmers Mfg. Co.
Leeds & Northrup Co.
United Cinephone Corp.

REGULATORS, AUTOMATIC, Pressure (See Controllers, Automatic, Pressure)

REGULATORS, AUTOMATIC, Pump
Allen-Bradley Co.
Arca Regulators, Inc.
Askania Regulator Co.
Atlas Valve Co.
Bailey Meter Co.
Belfield Co.
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Bristol Co.
Brown Inst. Co.
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Cash Co.
Davis Reg. Co.
D'Este Co.
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Ford Reg. Valve Co.
Foster Engg. Co.
Furnas Electric Co.
General Regulator Corp.
Hagan Corp.
Hanlon-Waters, Inc.
Hydraulic Press Co.
Klipfel Mfg. Co.
Leslie Co.
Mason-Neilan Regulator
McAlear Mfg. Co.
Mercon Regulator Co.
Northern Equip. Co.
Penn Electric Switch
Republic Flow Meters
Water Level Controls Co.
Schade Valve Mfg. Co.
Spence Engineering Co.
Tagliabue Mfg. Co.
Vaughn-G. E. Witt Co.
Watts Regulator Co.
Wilgus Mfg. Co.

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REGULATORS, AUTOMATIC, RKVA
Allis-Chalmers Mfg. Co.

REGULATORS, AUTOMATIC, Safety Fuel Shut-Off (See Valves, Automatic, Safety Fuel

REGULATORS, AUTOMATIC, Steam Pressure (See Regulators, Automatic, Pressure)

REGULATORS, AUTOMATIC, Synchronizing
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Industrial Engr. Corp.
Magnetic Gauge Co.

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REGULATORS, AUTOMATIC, Time (See Controllers, Automatic, Time)

REGULATORS, AUTOMATIC, Vacuum (See Controllers, Automatic, Vacuum)

REGULATORS, AUTOMATIC, Viscosity (See Controllers, Automatic, Viscosity)

REGULATORS, AUTOMATIC, Voltage
American Transformer
Amperite Corp.
Amplifier Co.
Burlington Inst. Corp.
Clarostat Mfg. Co.
Communication Meas. Lab.
Control Corp.
Eclipse Aviation
Electronic Prod. Co.
Ferris Inst. Corp.
Fredericks, George
General Elec. Co.
Ideal Commuto'r Dresser
International Resistance
Miller Co., Bertrand F.
Raytheon Mfg. Co.
Sola Electric Co.
United Cinephone Corp.
United Transformer Corp.
Ward Leonard Elec. Co.
Wheelco Instruments

REGULATORS, AUTOMATIC, Water Pressure (See Regulators, Automatic, Pressure)

REGULATORS, AUTOMATIC, Welding, Gas
Bastian-Blessing Co.
Victor Equipment Co.

REGULATORS, MANUAL (Non-Automatic)
Adel Precision
Allen-Bradley Co.
Bailey Meter Co.
Beck Bros.
Belfield Co.
Brown Inst. Co.
Cutler-Hammer, Inc.
Fisher Governor
Hanlon-Waters, Inc.
McAlear Mfg. Co.
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National Elec. Controller
Pioneer Instrument
Superior Electric Co.
Tagliabue Mfg. Co.
United Transformer Corp.
Ward Leonard Elec. Co.
Wheelco Instruments

RELAYS, Automatic
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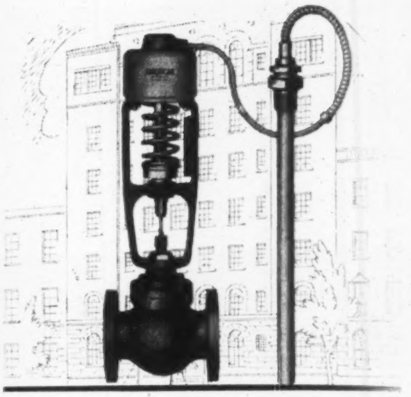
American Inst. Co.
American Automatic Elec.
Autocall Co.
Clare & Co.
Cook Electric Co.
Cutler-Hammer, Inc.
Eclipse Aviation
General Controls Co.
General Elec. Co.
Guardian Elec. Mfg. Co.
Hagan Corp.
H-B Elec. Co.
Industrial Eng. Corp.
Industrial Timer Corp.
Kellogg Switchboard
Mercoid Corp.
Minneapolis-Honeywell
Monitor Controller Co.
Paragon Electric Co.
Penn Electric Switch
Perfex Corp.
Roller-Smith Co.
Struthers-Dunn
Triplett Elec. Inst.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg
Weston Elec. Inst. Corp.

RELAYS, Capacity-Operated
Amer. Automatic Elec.
Electronic Lab.
Luxtrol Co., Inc.

RELAYS, Circuit Control
Advance Electric Co.
Allen-Bradley Co.
Allied Control Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
Automatic Switch Co.
Brown Inst. Co.
Clare & Co.
Cook Electric Co.
Electric Controller
Friez & Sons
General Elec. Co.
Guardian Elec. Mfg. Co
H-B Electric
Industrial Timer Corp.
Kellogg Switchboard
Kurman Electric
Leach Relay Co.
Lumenite Elec. Co.
Miller Co., Bertrand F.
Minneapolis-Honeywell
Monitor Controller Co.
Paragon Electric Co.
Precision Scientific
Roller-Smith Co.
Sigma Instruments, Inc.
Struthers-Dunn
Triplett Elec. Inst.
United Cinephone Corp.
Ward Leonard Elec. Co.
Western Electro-Mech.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.



What is HOT water?

The cost of maintaining hot water serv ice may be very high—especially if th temperature is not closely controlled.

The American Temperature Regula tor keeps the water temperature within set bounds preventing wastage from too hot water or steam and avoiding anno ance from too-cool hot water.

These are safe yet sensitive instruments re quiring the minimum of attention. Write to us for descriptive circular and information.

MAXWELL MANNING & MOORE INC. TRADE MARK
AMERICAN
Regulators
MANNING, MAXWELL & MOORE, INC.
BRIDGEPORT 2, CONNECTICUT

Power Relays

... for loads up to 30 AMPS.

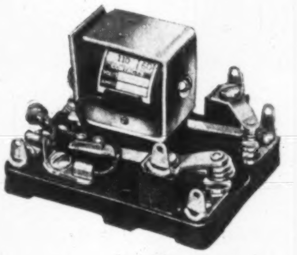
These low cost, reliable mercury plunger relay have withstood tests of ten million uninterrupted operations. Dust- and corrosion-proof with only on glass-enclosed moving part. Listed under th Re-examination Service of Underwriters Labor tories. Write today for Bulletin B.

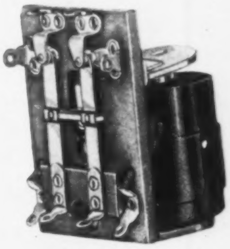
H-B ELECTRIC COMPANY
6118 No. 21st St. • Philadelphia 38, Pa

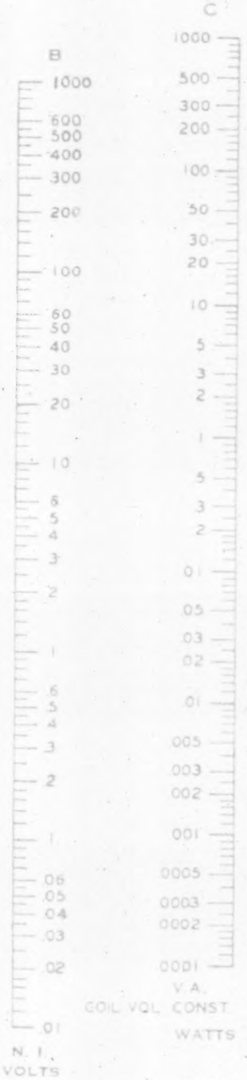
KURMAN CALCULATOR

Unknown values can be determined by placing a straight edge across the face of this nomograph joining two known values in any of the equations in the following table. The unknown value then occurs at the intersection of this straight edge with the proper vertical scale.

	SCALE A	SCALE B	SCALE C	SCALE D
$E = IR$	R (Ohms)	E (Volts)		I (Mils)
$W = E^2/R = I^2R$	R (Ohms)	E (Volts)	W (Watts)	I (Mils)
Volt—Amperes = VxA		V (Volts)	Volt—Amperes (VA)	A (Mils)
Ampere—Turns = NxI	N (Turns)	Ampere—Turns (NI)		I (Mils)
$ND^2 = K$	N (Turns)		K (Coil Vol. Const.)	D, Wire Diameter (Mils)


Series 5


Series 15



C
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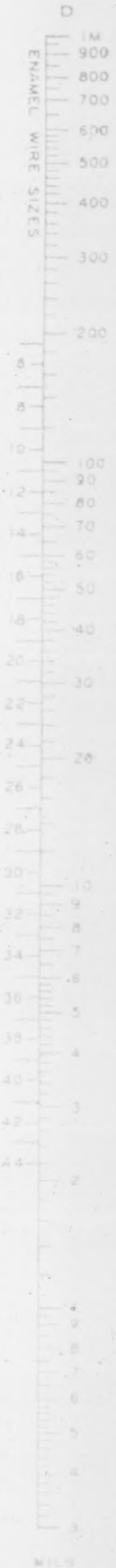
.0001
N. I.
VOLTS
V.A.
COIL VOL. CONST.
WATTS



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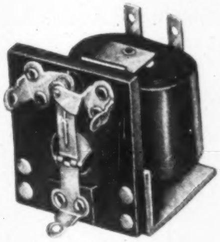
MILS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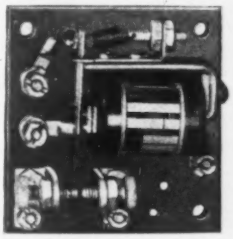
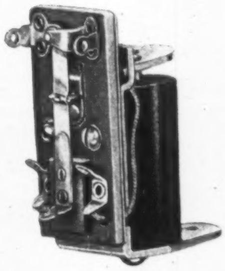

Series 21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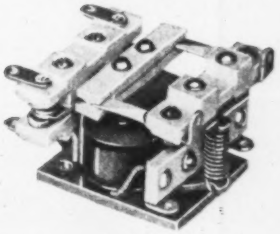
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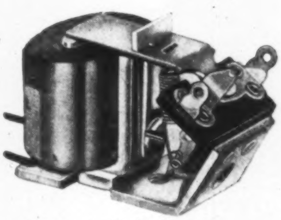
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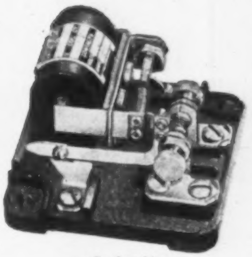

Series 31

GUIDE TO KURMAN RELAY SPECIFICATIONS

SERIES	RATED INPUT DC WATTS	RATED INPUT AC V.A.	AMPERE CONTACT RATING	WEIGHT OUNCES	DIMENSIONS INCHES	LIST PRICE
5	2.5	8	15	7½	3 x 2¼ x 2⅛	$4.25-$7.75
10	.35	——	.5	1½	1 5/16 x 1 x 1 3/16	$3.00-$4.00
11	.80	4.4	1	2⅛	1¾ x 13/16 x 1¾	$3.50-$6.50
12	.018	——	.25	1½	1⅜ x 1 1/16 x 15/16	$2.00-$3.00
15	2.0	6	1	3⅜	1¾ x 1 5/16 x 1¾	$4.25-$8.25
21	.014	.36	3	6¾	2⅝ x 2⅝ x 1⅝	$6.00-$10.50
25	2.0	4.0	10	4	2 1/16 x 1⅝ x 1 5/16	$3.75-$6.75
31	.014	.36	3	6⅝	2⅝ x 2⅝ x 1⅝	$6.00-$10.50

NOTES

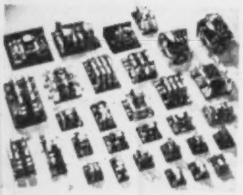
I. All current contact ratings are in amperes at 110 volts 60 cycle AC.
II. Dielectric strength of 1500 volts exists between contacts and ground in Series 10, 11, 15.
III. Insulated armature, shown on Series 31, is recommended for high frequency transfer. This feature may be specified for Series 21.
IV. Ferronickel alloy is used in the magnetic circuits for Series 12, 21, 31.
V. Ceramic insulation in Series 25 permits high frequency transfer with low capacitive leakage.
VI. Dampened armature action in Series 25 is designed to reduce contact bounce after initial pull down.
VII. Rated watts represents practical minimum input at standard adjustments.
VIII. All AC relays have a power factor of approximately .5.
IX. List prices vary with specific voltage and insulation requirements.

Copies of this calculator available on request.

KURMAN ELECTRIC CO., Inc.

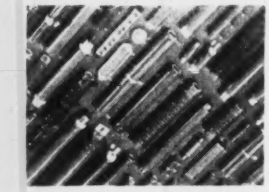
3518 37 STREET, LONG ISLAND CITY, NEW YORK

RELAYS



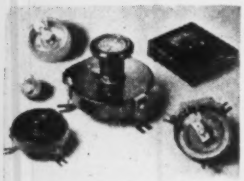
All Ward Leonard Relays have crisp action, are dependable and durable. Various Ward Leonard Relays are described in "W. L. Relay Bulletins."

RESISTORS



Ward Leonard Resistors cover a wide range of sizes, ratings, enclosures and terminals. "W. L. Resistor Bulletins" are resistor reference guides.

RHEOSTATS



W. L. Rheostats include everything from fractional H. P. types to the largest multiple units. Described in "W. L. Rheostat Bulletins."

Send for Data Bulletins

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Electric control (WL) devices since 1892.

WARD LEONARD ELECTRIC COMPANY, 38 South St., Mt. Vernon, N. Y.

PREVENT DAMAGE TO YOUR INSTRUMENTS

Before it Occurs!

SIGMA
Type 5F
1⅜"x 1⅜"x 1⅝"
Weight, 3½ oz.
SIGMA
Type 4R
1½"x 1½"x 2
Above Socket

Use Sigma Sensitive Relays for the protection of your instruments and test equipment:

- Time delay
- Current Overload, AC or DC
- Operation on as little as .0005 watt
- Coil resistance from .001 to 20,000 ohms

Proof against shock, humidity, temperature, altitude and vibration . . . Send for free bulletin data.

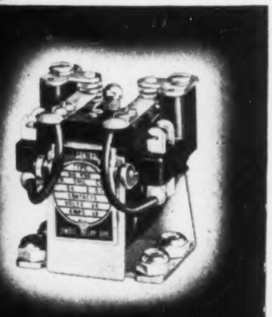
SIGMA

Sigma Instruments, INC.

Sensitive RELAYS

78 Freeport St., Dorchester 22, Mass.

RELAYS...
for Aircraft, Mobile and Industrial Equipment
BY ALLIED



Sensitive... Plate circuit and Power types ... single or double throw... 1 to 6 pole.

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NEW YORK 21, N. Y.

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American Inst. Co.
Autocall Co.
Clare & Co.
Cook Electric Co.
General Elec. Co.
Guardian Elec. Mfg. Co
H-B Electric
Industrial Timer Corp.
Kellogg Switchboard
Paragon Electric Co.
Sigma Instruments
Struthers-Dunn
Triplett Elec. Inst.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Control
Allen-Bradley Co.
Advance Electric Co.
Allied Control Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
Automatic Switch Co.
Barber-Coleman
Betts & Betts
Brown Inst. Co.
Clare & Co.
Control Corp.
Cook Electric Co.
Cutler-Hammer, Inc.
Electric Controller
Friez & Sons
General Controls Co.
General Elec. Co.
Guardian Elec. Mfg. Co.
Hagan Corp.
H-B Electric
Industrial Eng. Corp.
Kellogg Switchboard
Kurman Electric
Miller Co., Bertrand F.
Minneapolis-Honeywell
Monitor Controller Co.
National Time & Signal
Perfex Corp.
Precision Therm.
Roller-Smith Co.
Sigma Instruments
Struthers-Dunn
Triplett Elec. Inst.
United Cinephone Corp.
Ward Leonard Elec. Co.
Western Electro-Mech.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Demand Totalizing
Amer. Automatic Elec.
Autocall Co.
General Elec. Co.
Hagan Corp.
Therm-Electric Meters Co.
United Cinephone Corp.
Westinghouse Elec. & Mfg.

RELAYS, Electromagnetic
Advance Electric Co.
Allen-Bradley Co.
Allied Control Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
Automatic Switch Co.
Bender Warrick
Birtcher Corp.
Bunnell & Co.
Cook Electric Co.
Eby, Inc.
Clare & Co.
Cutler-Hammer, Inc.
Friez & Sons
General Elec. Co.
G-M Labs.
Guardian Elec. Mfg. Co.
Haydon Mfg. Co.
H-B Electric
Industrial Eng. Corp.
Kellogg Switchboard
Kurman Electric Co.
Leach Relay Co.
Miller Co., Bertrand F.
Minneapolis-Honeywell
Monitor Controller Co.
National Time & Signal
Penn Electric Switch Co.
Perfex Corp.
Phila. Thermometer Co.
Precision Scientific
Precision Therm. & Inst.
Sigma Instruments, Inc.
Struthers-Dunn
Triplett Elec. Inst.
United Cinephone Corp.
Ward Leonard Elec. Co.
Western Electro-Mech.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
White-Rodgers Electric
Zenith Electric Co.

RELAYS, Electronic
Automatic Temp. Control
Bell & Howell
Cardwell Mfg. Corp.
Clare & Co., C. P.
Coleman Electric
Cramer Co., Inc.
Davis & Co., Inc., Dean
Echo Electrical
Electro-Medical Lab.
Ess Instrument
Guardian Elec. Mfg.
Photobell Corp.
Sigma Instruments
Televiso Products
United Cinephone

RELAYS, Frequency
Allied Control Co.
Amer. Automatic Elec.
Autocall Co.
Clare & Co., C. P.
Control Corp.
Cutler-Hammer, Inc.
Esterline-Angus Co.
Hickok Electrical Inst.
Sigma Instruments
United Cinephone Corp.
Ward Leonard Electric Co.
Westinghouse Elec. & Mfg.

RELAYS, Galvanometer
Amer. Automatic Elec.
Autocall Co.
Eby, Inc., Hugh H.
G-M Laboratories, Inc.
Roller-Smith Co.
Rubicon Co.
Tagliabue Mfg. Co., C. J.

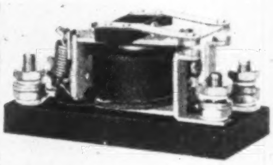
RELAYS, Heavy Duty
Allen-Bradley Co.
Allied Control Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
Automatic Switch Co.
Cutler-Hammer, Inc.
General Elec. Co.
H-B Electric
Miller Co., Bertrand F.
Monitor Controller Co.
Penn Electric Switch
Philadelphia Thermometer
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Zenith Electric Co.

RELAYS

AC OR DC

by GUARDIAN

AC—Series 170 **DC—Series 175**

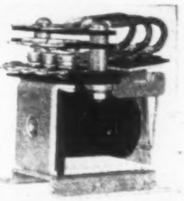


Type B2A Relay

The B2A relay is one of the most versatile of all aircraft relays and has numerous variations. Contacts are rated at 25 amps. continuous, 100 amps. surge. Contact combination: single pole, single throw, normally open, double make (on model shown.) Voltage range: 18-29 volts D.C. Size: 3⅛″ x 1⅜″ x 1 9/16″. Weight: 5½ oz.

Write for bulletin.

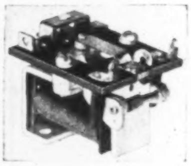
A general purpose radio relay designed for aircraft use. Contact combinations up to three pole, double throw. Coil resistances range from .01 ohm to 15,000 ohms. Standard voltage: 16-32 volts D.C. Available with delayed release or delayed attract. Size: 2 1/32″ x 1 11/16″ x 2⅜″. Weight: 6½ oz. Also available with copper slug time delay on attract or release. May be equipped with solder lug or screw terminals.



AC—Series 340 **DC—Series 345**

Write for bulletin.

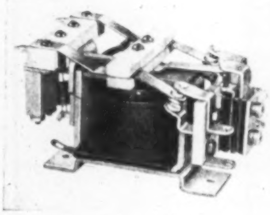
MIDGET



Heretofore relays displacing as much as 6 cubic inches were considered to be in the "midget" class. The series 195 displaces only 1.14 cubic inches. Contact rating: 1.5 amps. Up to double pole, double throw combination. Standard voltage 18-24 volts D.C. Coils available for voltages up to 75 volts D.C. Weight: .85 oz. (SPDT).

DC only—Series 195

HF & UHF



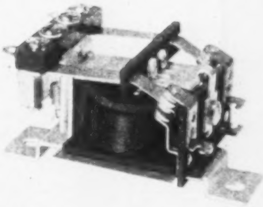
Series 260A

One of several HF & UHF types of relays for use in antenna switching circuits, heating equipment, and other industrial applications. Contact rating: 1 KW at frequencies up to 28 Mc. Combination: double pole, double throw with auxiliary single pole, single throw contact. Voltage: 90-125 volts A.C. Size: 1⅞″ x 3⅛″ x 1 13/16″. Weight: 10 Oz.

AIRCRAFT

Vibration Resistant

Write for Guardian's catalog of Aircraft relays "Aircraft Controls."



Designed for applications having a serious vibration problem. Switch capacity: 12½ amps. Ceramic insulated with contacts rated at 1000 watts at 28 megacycles for HF and UHF applications. Sizes: 2½″ x 1⅝″ x 1 9/16″. Weight: 5 ounces. (DPST).

AC—Series 160 **DC—Series 165**

Ceramic insulated—Series 165A

MULTIPLE CONTACT

Switch capacity: 10 pole, single throw with 1½ amp. contacts. Power requirements: 9 VA (AC); 3 watts (DC). AC has laminated field piece and armature and is used in primary control scoreboard circuits, etc. DC used in turnstile controls, remote control fractional HP motors, etc. Size: (DC) 2¾″ x 2¾″.

AC—Series 30 **DC—Series 15**

GUARDIAN ELECTRIC

1638 W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

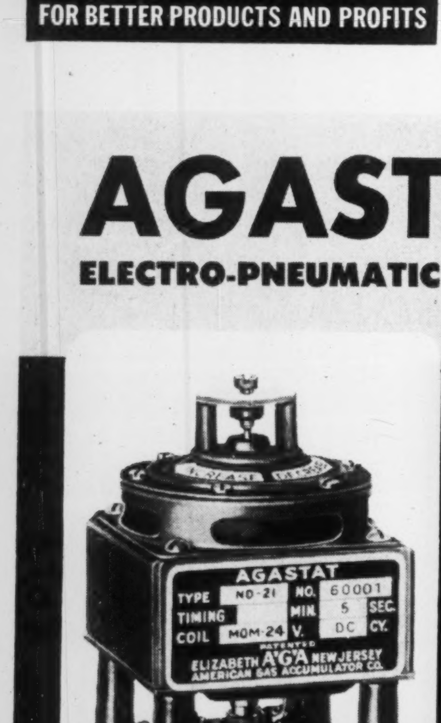
BRISTOL'S METAMETER

Offered for remote measurement (any distance) of pressure, flow, temperature, liquid level, motion and gate position, voltage, current power, totalized power load, and reactive volt amperes. Transmission may be over telephone circuits, private wires, or carrier current channels. Also remote automatic control. The Bristol Co., 113 Bristol Road, Waterbury 91, Conn.

BRISTOL

ENGINEERS PROCESS CONTROL FOR BETTER PRODUCTS AND PROFITS

AGASTAT
ELECTRO-PNEUMATIC RELAY



COMPACT:
4 IN. HIGH
2½ IN. DEEP
2½ IN. WIDE
WEIGHT:
1½ POUNDS

ELIZABETH A'G'A NEW JERSEY
AMERICAN GAS ACCUMULATOR COMPANY

RELAYS, Instrument Controlled
Allied Control Co.
American Automatic Elec.
American Inst. Co.
Autocall Co.
Barber-Colman
Brown Inst. Co.
Clare & Co.
Cook Electric Co.
Cramer & Co., Inc.
Friez & Sons
General Elec. Co.
Guardian Elec. Mfg. Co.
H-B Electric
Kurman Electric Co.
Minneapolis-Honeywell
Perfex Corp.
Phila. Thermometer Co.
Precision Scientific
Precision Therm.
Roller-Smith Co.
Struthers-Dunn
Tagliabue Mfg. Co.
Triplett Electrical Inst.
United Cinephone Corp.
Ward Leonard Elec. Co.
Weston Elec. Inst. Corp.

RELAYS, Light Sensitive (See Photoelectric below)

RELAYS, Magnetic (See Relays, Electro-Magnet)

RELAYS, Mercury
American Automatic Elec.
American Inst. Co.
Autocall Co.
Continental Elec. Co.
Guardian Electric
H-B Elec. Co., Inc.
Precision Scientific
Precision Therm.
Weston Elec. Inst. Corp.

RELAYS, Mercury Tube
Amer. Automatic Elec.
American Inst. Co.
Autocall Co.
Brown Inst. Co.
Clare & Co.
Struthers-Dunn
General Controls Co.
G-M Labs.
Guardian Elec. Mfg. Co.
H-B Elec. Co., Inc.
Minneapolis-Honeywell
Phila. Thermometer
Precision Therm.
Ward Leonard Elec. Co.
Weston Elec. Inst. Corp.

RELAYS, Motor Driven Time Delay
Advance Electric Co.
American Inst. Co.
Barber-Colman
Betts & Betts
Controls, Inc.
Cramer & Co., Inc.
Struthers-Dunn
Friez & Sons
General Elec. Co.
Haydon Mfg. Co.
Industrial Eng. Corp.
Industrial Timer
Monitor Controller Co.
Paragon Electric Co.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
Zenith Electric Co.

RELAYS, Movable Coil A.C.
Esterline-Angus Co.
General Elec. Co.
Roller-Smith Co.
Triplett Elec. Inst.
Weston Elec. Inst. Corp.

RELAYS, Overload
Allen-Bradley Co.
Allied Control Co.
Amer. Automatic Elec.
Autocall Co.
Bunnell & Co.
Burlington Inst. Corp.
Cutler-Hammer, Inc.
Struthers-Dunn
Edison, Instrument Div.
Electric Controller
General Elec. Co.
Guardian Elec. Mfg. Co.
Leach Relay Co.
Penn Electric Switch
Roller-Smith Co.
Sigma Instruments
Standard Elect. Prods.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.

RELAYS, Permanent Magnet Movable Coil
Bunnell & Co.
Esterline-Angus Co.
General Elec. Co.
Roller-Smith Co.
Triplett Electrical Inst.
Weston Elec. Inst. Corp.

RELAYS, Photoelectric
Advance Electric Co.
Allied Control Co.
American Inst. Co.
Eby, Inc.
Clare & Co.
Continental Elec. Co.
Cutler-Hammer, Inc.
Dickson Co.
Electronic Lab.
Electronic Prod. Co.
Ess Instrument Co.
General Controls Co.
General Elec. Co.
G-M Labs.
Leach Relay Co.
Lipman Engg. Co.
Lumenite Elec. Co.
Photobell Corp.
Photoswitch, Inc.
Precision Therm.
Rehtron Corp.
Rubicon Co.
Sigma Instruments, Inc.
Tagliabua Mfg. Co.
Triplett Elec. Inst.
United Cinephone Corp.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst Corp.

RELAYS, Polarized
Allied Control Co.
American Automatic Elec.
Autocall Co.
Struthers-Dunn
Edison, Instrument Div.
L. A. B. Corp.
Miller Co., Bertrand F.
Precision Therm. & Inst.
Sigma Instruments
Triplett Elec. Inst.
Utah Radio Prods.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Power
Allied Control Co.
Amer. Automatic Elec.
(Max. 10 Amps.)
American Inst. Co.
Automatic Switch Co.
Struthers-Dunn
Esterline-Angus Co.
General Controls Co.
General Elec. Co.
Hagan Corp.
H-B Electric
Roller-Smith Co.
Ward Leonard Elec. Co.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

RELAYS, Power Factor
Esterline-Angus Co.
L. A. B. Corp.
Westinghouse Elec. & Mfg.

RELAYS, Resistance, D-c.
Advance Electric Co.
Allied Control Co.
Autocall Co.
Automatic Electric Co.
Bunnell & Co.
Clare & Co., C. P.
Cook Electric Co.
Cutler-Hammer, Inc.
Dunn, Inc., Struthers
Guardian Electric
Haydon Mfg. Co.
Leach Relay Co.

RELAYS, Stepping
Allied Control Co.
Autocall Co.
Automatic Electric Co.
Dunn, Inc., Struthers
G-M Laboratories, Inc.
Guardian Electric
Roller-Smith Co.

RELAYS, Telephone Auxiliary Ringing
Advance Electric Co.
Allied Control Co.
American Automatic Elec.
Autocall Co.
Clare & Co.
Struthers-Dunn
Kellogg Switchboard
Kurman Electric Co.
Leach Relay Co.
Western Electro-Mech.

RELAYS, Temperature
Autocall Co.
Clare & Co., C. P.
Cook Electric Co.
Dunn, Inc., Struthers
Edison, Instrument Div.
Friez & Sons
Gleason-Avery, Inc.
G-M Laboratories, Inc.
Guardian Electric
Leach Relay Co.
Minneapolis-Honeywell
Photobell Corp.
Spencer Thermostat Co.
Tagliabue Mfg. Co., C. J.
Triplett Elec. Inst.
United Cinephone Corp.
Westinghouse Elec. & Mfg.
Weston Electrical Inst.

RELAYS, Thermal Time Delay
Advance Electric Co.
Allen-Bradley Co.
Allied Control Co.
American Automatic Elec.
Am. Gas Accumulator
American Inst. Co.
Autocall Co.
Automatic Temp. Control
Betts & Betts
Cook Electric Co.
Cramer & Co., Inc.
Cutler-Hammer, Inc.
Struthers-Dunn
Eagle Signal Corp.
Echo Electrical
Edison, Instrument Div.
Electric Controller
Electronic Prod. Co.
Friez & Sons, Jr.
General Elec. Co.
Guardian Elec. Mfg. Co.
Haydon Mfg. Co.
Industrial Eng. Corp.
Magnetic Gauge Co.
Paragon Electric Co.
Perfex Corp.
Photobell Corp.
Precision Therm.
Preferred Utilities Mfg.
Roller-Smith Co.
Spencer Thermostat Co.
Ward Leonard Elec. Co.
Weston Elec. Inst. Corp.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
White-Rodgers Electric
Zenith Electric Co.

RELAYS, Time Delay (See Relays, Thermal Time Delay)

RELAYS, Transformer (Low Voltage)
Allen-Bradley Co.
Allied Control Co.
Automatic Electric
Struthers-Dunn
Eclipse Aviation
Friez & Sons
General Controls Co.
Gleason-Avery, Inc.
Guardian Elec. Mfg. Co.
H-B Electric
Industrial Eng. Corp.
Miller Co., Bertrand F.
Minneapolis-Honeywell
Paragon Electric Co.
Penn Electric Switch
Perfex Corp.
Sigma Instruments, Inc.
Ward Leonard
Westinghouse Elec. & Mfg.
White-Rodgers Electric

RELAYS, Vacuum Contact
American Automatic Elec.
American Inst. Co.
Edison, Instrument Div.

RELAYS, Vacuum Tube
Allied Control Co.
American Inst. Co.
Automatic Elec.
Continental Elec. Co.
Struthers-Dunn
Eby, Inc.
Electro-Medical Lab.
Electronic Prod. Co.
General Controls Co.
General Elec. Co.
G-M Labs.
L. A. B. Corp.
Lumenite Elec. Co.
Metron Instrument
Photobell Corp.
Precision Therm.
Sargent & Co.
Sigma Instruments
Tagliabue Mfg. Co.
United Cinephone Corp.

RELAYS, Voltage
Advance Electric Co.
Allen-Bradley Co.
Allied Control Co.
Autocall Co.
Automatic Elec.
Automatic Switch Co.
Barber-Colman
Clare & Co., C. P.
Cutler-Hammer, Inc.
Dunn, Inc., Struthers
Eby, Inc., Hugh H.
Esterline-Angus Co.
Ferranti Electric, Inc.
Hart Manufacturing Co.
Hathaway Inst. Co.
Kurman Electric
Leach Relay Co.
Photobell Corp.
Reliance Instrument Co.
Roller-Smith Co.
Sigma Instruments
Ward Leonard Electric Co.
Triplett Electrical Inst.
Westinghouse Elec. & Mfg.
Weston Electrical Inst.

REMOTE-CONTROL EQUIPMENT
Adel Precision
Allen-Bradley Co.
Allied Control Co.
American Automatic Elec.
Atlas Valve Co.
Autocall Co.
Bailey Meter Co.
Barber-Colman
Bristol Co.
Brooke Eng. Co.
Brown Inst. Co.
Builders Providence
Clare & Co.
Control Corp.
Cutler-Hammer, Inc.
Davis Reg. Co.
Elec. Indicator Corp.
Electrimatic Corp.
Electronic Lab.
Elsbert Mfg. Co.
Fischer & Porter
Foxboro Co.
General Elec. Co.
Globe Industries
Guardian Electric
Hagan Corp.
Hanlon-Waters, Inc.
Hart Mfg. Co.
Hays Corp.
H-B Electric
Illinois Eng. Co.
Infilco, Inc.
Kollsman Inst. Co.
Kurman Electric Co.
Mason-Neilan Regulator
Minneapolis-Honeywell
Perfex Corp.
Photobell Corp.
Pioneer Instrument
Powers Regulator Co.
Republic Flow Meters
Scientific Inst. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
United Cinephone Corp.
Wheelco Instruments
Zenith Electric Co.

REMOTE-METERING EQUIPMENT, ELECTRICAL
Anderson Co.
Andrew, Victor J.
Automatic Temp. Control
Bristol Co.
Brown Inst. Co.
Builders-Providence
Control Corp.
Elec. Indicator Corp.
Elec. Tachometer Corp.
Esterline-Angus Co.
Fischer & Porter
Foxboro Co.
General Elec. Co.
W. & L. E. Gurley
H & H Thermostats
Kellogg Switchboard
Kurman Electric Co.
L. A. B. Corp.
Leeds & Northrup Co.
Mason-Neilan Regulator
Moisture Register Co.
Morey & Jones, Ltd.
Pioneer Instrument
Republic Flow Meters
Tagliabue Mfg. Co.
Therm-Electric Meters
Westinghouse Elec. & Mfg.

REMOTE-METERING EQUIPMENT, HYDRAULIC
Builders-Providence
Infilco, Inc.
Leupold & Stevens
Westinghouse Elec. & Mfg.

REMOTE-METERING EQUIPMENT, PNEUMATIC
American Meter Co.
Bristol Co.
Brown Inst. Co.
Builders-Providence
Foxboro Co.
Mason-Neilan Regulator
Moore Products
Taylor Inst. Cos.

RESISTANCE LOADING EQUIPMENT
De Jur-Amsco
Eastern Specialty Co.
Hardwick, Hindle, Inc.
International Resistance.
Precision Resistor Co.
Shallcross Mfg.
Ward Leonard

OHMITE
RESISTORS · RHEOSTATS · TAP SWITCHES
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CHICAGO, U.S.A.
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Your "Answer Book" to Resistance Problems

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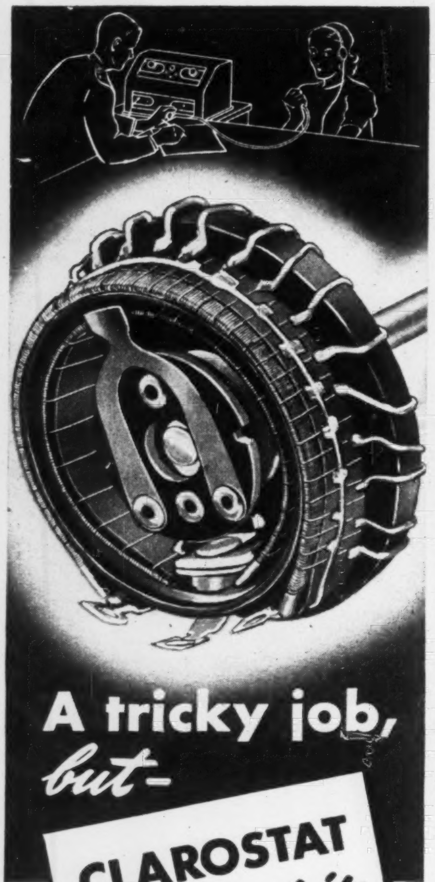

★A leading concern in the hearing-aid field, noted for its technical proficiency, needed just one component to perfect its audiometer or electronic instrument designed to determine the extent and nature of a hearing impairment. A special attenuator was required—one with continuous and tapped windings properly combined, providing critical incremental steps with resistance values between.

The problem soon came to Clarostat—as do most "can't be done" jobs. Clarostat engineers soon evolved the intricate attenuator here shown. And Clarostat skilled workers, provided with winding equipment second to none, produced these special controls. Which simply means to you:

★ Submit that problem dealing with controls or resistors to Clarostat for engineering aid. Engineering data sent on request.

CLAROSTAT *Controls and Resistors*

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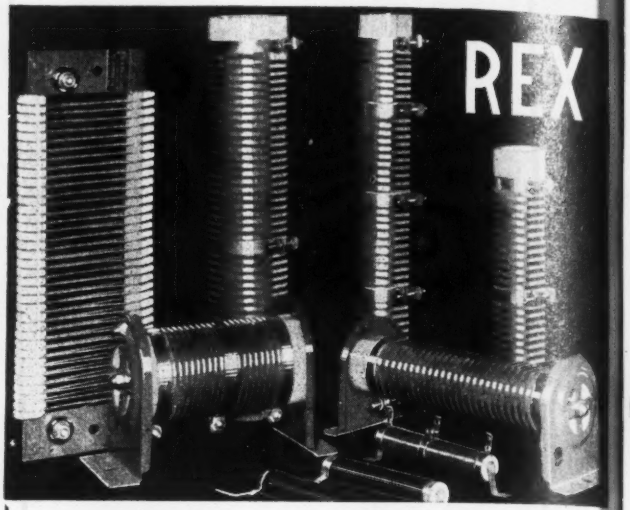
WIRE-WOUND & COMPOSITION-ELEMENT CONTROLS ★ POWER RHEOSTATS ★ POWER RESISTORS ★ FLEXIBLE RESISTORS ★ GLASOHMS (Glass-Insulated Resistors) ★ ATTENUATORS ★ BALLASTS, Etc., etc.



Tubular Slide-Contact Rheostats and Resistors
REX RHEOSTAT CO. BALDWIN L. I., N. Y.

RESISTANCES
- Allen-Bradley Co.
- Automatic Elec.
- Beck Bros.
- Central Scientific Co.
- Clarostat Mfg. Co.
- Cutler-Hammer, Inc.
- **Daven Co.**
- **General Radio Co.**
- **Instrument Resistors,**
- **International Resistance**
- **Mallory & Co.**
- **Ohmite Mfg. Co.**
- Precision Resistor Co.
- **Rubicon Co.**
- **Sensitive Research Inst.**
- **Shallcross Mfg. Co.**
- Utah Radio Prods.
- **Ward Leonard**

RESISTORS, Adjustable
- Allied Radio Corp.
- **De Jur-Amsco**
- **Mallory & Co.**
- **Ohmite Mfg. Co.**
- Utah Radio Produs.
- **Ward Leonard Electric Co.**

RESISTORS, Carbon Compression
- Allen Bradley Co.
- Beck Bros.
- **International Resistance**
- Le Carbone Co., Inc.
- Nat'l Carbon Co., Inc.
- Ohio Carbon Co.
- **O. S. Peters**
- Speer Carbon Co.
- **Welch Mfg. Co.**

RESISTORS, High Frequency
- Beck Bros.
- Daven Co.
- **General Radio Co.**
- Hardwick, Hindle, Inc.
- Instrument Resistors, Inc.
- **International Resistance**
- **Leeds & Northrup Co.**
- **Mallory & Co.**
- **Measurements Corp.**
- **Ohmite Mfg Co.**
- **Shallcross Mfg. Co.**
- **Ward Leonard Electric Co.**

RESISTORS, High Voltage
- Beck Bros.
- **Clarostat Mfg Co.**
- Cole Instrument
- Hardwick, Hindle, Inc.
- Instrument Resistors, Inc.
- **International Resistance**
- J B L Instrument Co.
- **Ohmite Mfg. Co.**
- **Shallcross Mfg. Co.**
- **Ward Leonard Electric Co.**

RESISTORS, Manganin
- Beck Bros
- Cole Instrument
- Daven Co.
- **De Jur-Amsco**
- **General Radio Co.**
- Gray Instrument Co.
- Hardwick, Hindle, Inc.
- Instrument Resistors, Inc.
- **Leeds & Northrup Co.**
- **Ohmite Mfg. Co.**
- **Rubicon Co.**
- **Shallcross Mfg. Co.**

RESISTORS, Molded
- Allen-Bradley Co.
- Beck Bros.
- **Clarostat Mfg. Co.**
- **International Resistance**
- Muter Co
- **Triplett Electrical Inst.**

RESISTORS, Standard (See Standards, Resistance)

RESISTORS, Variable
- Allen-Bradley Co.
- Allied Radio Corp.
- Beck Bros.
- **Clarostat Mfg. Co.**
- Cutler-Hammer, Inc.
- **De Jur-Amsco**
- **General Radio Co.**
- Gray Instrument Co.
- Hardwick, Hindle, Inc.
- Instrument Resistors, Inc.
- **International Resistance**
- **Leeds & Northrup Co.**
- **Mallory & Co.**
- **National Electric Control.**
- **Ohmite Mfg. Co.**
- **Rex Rheostat Co.**
- **Rubicon Co.**
- **Shallcross Mfg.**
- Utah Radio Produs.

RESISTORS, Wire Wound
- Allied Radio Corp.
- Associated Research
- Automatic Elec.
- Beck Bros.
- **Biddle Co., Jas. G.**
- **Clarostat Mfg. Co.**
- Cole Instrument
- Cutler-Hammer, Inc.
- Daven Co.
- **De Jur-Amsco**
- **General Radio Co.**
- **Gray Instrument Co.**
- Hardwick, Hindle, Inc.
- Instrument Resistors, Inc.
- **International Resistance**
- **Leeds & Northrup Co.**
- **Mallory & Co.**
- Muter Co.
- **National Electric Control.**
- **Ohmite Mfg Co.**
- **Rex Rheostat Co.**
- **Rubicon Co.**
- **Shallcross Mfg. Co.**
- **Triplett Electrical Inst.**
- Utah Radio Prods.
- **Ward Leonard Electric Co.**

RHEOSTATS, Battery Charging
- Allen-Bradley Co.
- Beck Bros.
- Cutler-Hammer, Inc.
- **De Jur-Amsco**
- Hardwick, Hindle, Inc.
- **International Resistance**
- **National Elec. Controller**
- **Ohmite Mfg. Co.**
- **Rex Rheostat Co.**
- Schaefer Bros. Co.
- **Ward Leonard Elec. Co.**

RHEOSTATS, Laboratory
- Allen-Bradley Co.
- **American Inst. Co.**
- Beck Bros.
- **Biddle Co., Jas. G.**
- **De Jur-Amsco Corp.**
- Central Scientific Co.
- Chicago Apparatus Co.
- Eastern Specialty Co.
- **General Radio Co.**
- **G-M Labs.**
- Hardwick, Hindle, Inc.
- **Mallory & Co.**
- **National Elec. Controller**
- **National Tech. Labs.**
- **Ohmite Mfg. Co.**
- **Rex Rheostat Co.**
- **Rubicon Co.**
- Schaefer Bros. Co.
- **Ward Leonard Elec. Co.**

RHEOSTATS, Meter Testing
- Allen-Bradley Co.
- Beck Bros.
- **Biddle Co., Jas. G.**
- **De Jur-Amsco Corp.**
- Eastern Specialty Co
- Hardwick, Hindle, Inc.
- **International Resistance**
- **Leeds & Northrup**
- **National Elec. Controll**
- **Ohmite Mfg. Co.**
- **Shallcross Mfg.**
- **Ward Leonard Elec. Co**

RHEOSTATS, Slide Wir
- Beck Bros.
- **Biddle Co., Jas. G.**
- Central Scientific Co.
- Chicago Apparatus Co
- **General Radio Co.**
- Hardwick, Hindle, Inc
- **Leeds & Northrup**
- **National Elec. Controll**
- **National Tech. Labs.**
- **Rex Rheostat Co.**
- **Rubicon Co.**
- **Shallcross Mfg. Co.**
- Utah Radio Prods.
- **Ward Leonard Elec. Co**

RIDEOMETERS, RIDE COMFORT Recorders & Riding-Quality Instruments
- **Commercial Research**
- **Impact Register Co.**
- Jaeger Watch Co.
- **Sperry Products, Inc.**
- **Waugh Laboratories**

RULES, Adjustable Curv (See Drawing Instruments)

RULES, Aluminum
- Keuffel & Esser Co.
- Lufkin Rule Co.
- Warren-Knight Co

RULES, Brass
- Bliss & Co.
- Lufkin Rule Co.
- Mico Instrument Co.
- Starrett Co.
- Warren-Knight Co

RULES, Caliper
- Glogau & Co.
- Lufkin Rule Co.
- Millers Falls Co.
- Starrett Co.
- Union Tool Co.
- Warren-Knight Co

RULES, Drafting Roo (See Drawing Instr ments)

RULES, Folding
- Bliss & Co.
- Dietzen Co.
- Keuffel & Esser Co.
- Lufkin Rule Co.
- Post Co., Frederick
- Speidel & Co.
- Starrett Co.
- Warren-Knight Co
- Weber Co.

RULES, Glass
- **Fish-Schurman Co.**
- **Glass Engraving Co.**
- Mico Instrument Co

THE BECKMAN HELIPOT

A Wide Range Potentiometer-Rheostat for Quality Instruments

Cutaway View of Helipot

THE Beckman Helipot is a *new* kind of potentiometer-rheostat combining—*in one compact unit*—unusually wide range with extreme fineness of adjustment. Heretofore it has been necessary to use two units for complete resistance control—a wide range unit for coarse adjustment and a narrow range unit for fine adjustment . . . *two units . . . two knobs . . . two operations.* With the Beckman Helipot there is only *one unit . . . one knob . . . one operation!*

The Helipot consists essentially of a long potentiometer slide wire coiled helically into a small case, with a slider contact rotated in the usual manner by a knob. By means of a simple guide wheel, the slider contact automatically follows the helical path of the resistance winding. For a helical winding of 9 turns, the Helipot has—for the same fineness of adjustment—9 times the range of the ordinary single turn potentiometer-rheostat. Or, conversely, for the same *range*, the Helipot can be adjusted 9 times as closely. *Yet it occupies no more panel space than conventional potentiometers!*

The Helipot is precision built throughout and is designed for use in instruments of the highest quality. Available in 3 and 9 turn models, resistances 30 to 30,000 ohms. *Write for details!*

BECKMAN INSTRUMENTS • National Technical Laboratories
SOUTH PASADENA, CALIFORNIA

RULES, Parallel
Bliss & Co.
Dietzen Co.
Hamilton Mfg. Co.
Keuffel & Esser Co.
Negus, T. S. & J. D.
Speidel & Co.
Warren-Knight Co.
White Co., Inc.
Weber Co.

RULES, Precision Standard
Gaertner Scientific Corp.

RULES, Shrinkage
Keuffel & Esser Co.
Lufkin Rule Co.
Speidel & Co.
Starrett Co.
Warren-Knight Co.
Weber Co.

RULES, Slide (See Drawing Instruments)

RULES, Slide, Psychrometric
Friez & Sons

RULES, Steel
Kern Co.
Keuffel & Esser Co.
Lufkin Rule Co.
Mico Instrument Co.
Millers Falls Co.
Scherr Co., Inc.
Speidel & Co.
Starrett Co.
Union Tool Co.
Warren-Knight Co.
Weber Co.

RULES, Wood
Henschel & Co.
Keuffel & Esser Co.
Lufkin Rule Co.
Post Co., Frederick
Speidel & Co.
Warren-Knight Co.
Weber Co.

RUNNING TIME TOTALIZERS
Cramer & Co., Inc.
Elec. Tachometer Corp.
Jaeger Watch Co.
Production Instrument

SACCHARIMETERS
Akatos, Inc.
Bausch & Lomb Opt.
Central Scientific Co.
Elmer & Amend
Jarrell-Ash Co.
Kimble Glass
Moeller Instrument Co.
Rieker Inst. Co.
Sargent & Co.
Trerice Co.

SACCHAROMETERS
Central Scientific Co.
Eimer & Amend
Fleischhauer & Son
G. M. Mfg. Co., Inc.
H.B Inst. Co.
Kimble Glass Co.
Moeller Instrument Co.
Precision Therm. & Inst.
Rascher & Betzold
Rieker Inst. Co.
Ruehfel Co.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Wagner & Son

SALINITY INDICATORS
Bendix Marine Products
Central Scientific Co.
Eimer & Amend
Engineering Labs., Inc.
Fleischhauer & Son
G. M. Mfg. Co., Inc.
H-B Inst. Co.
Leeds & Northrup Co.
McNab of Bridgeport
Moeller Inst. Co.
Precision Therm. & Inst.
Rascher & Betzold
Rubicon Co.
Ruehfel Co.
Schultheis Corp.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Trerice Co.
Westinghouse Elec. & Mfg.

SALINOMETERS (See Salinity Indicators)

SAMPLER, Boiler Water
Natl Aluminate Corp.

SAMPLERS, Oil
Braun Corp.
Central Scientific Co.
Pgh. Equitable Meter
Precision Scientific
Refinery Supply Co.
Scientific Glass Apparatus
Tagliabue Mfg. Co.

SAMPLERS, Oil Bottomhole
Ruska & Co., Inc.

SAMPLERS, Sewage
Builders-Providence
Central Scientific Co.
Infilco, Inc.
Precision Scientific
Scientific Glass Apparatus

SAMPLERS, Silt
Central Scientific Co.

SCALES (See also object of measurement)

SCALES, Antimony Test
Howe Scale Co.
Seederer-Kohlbusch, Inc.
Troemner, Henry

SCALES, Automatic
Automatic Scale Co.
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co., Inc.
Kron Co.
Merrick Scale Mfg. Co.
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.
Triangle Package Mach.
Triner Sales Co.

SCALES, Bag Filling
Automatic Scale Co.
Exact Weight Scale Co.
Fairbanks, Moore & Co.
Gump Co.
Jacobs Bros. Co.
Kron Co.
Richardson Scale Co.
Toledo Scale Co.
Triangle Package Mach.

SCALES, Basis Weight
Amthor Testing Inst. Co.
Becker, Inc., Christian
Buffalo Scale Co.
Exact Scale Co.
Howe Scale Co.
Kron Co.
Seederer-Kohlbusch
Thwing-Albert Instrument
Toledo Scale Co.
Torsion Balance Co.
Triner Sales Co.

SCALES, Bulk Weighing
Becker, Inc., Christian
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Jacobs Bros. Co.
Kron Co.
Merrick Scale Mfg.
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.
Torsion Balance Co.
Triangle Package Mach.
Triner Sales Co.
Troemner, Henry

SCALE, Cement Batching
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.
Triner Sales Co.

SCALES, Checking
Becker, Inc., Christian
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Jacobs Bros. Co., Inc.
Kron Co.
Merrick Scale Mfg. Co.
Richardson Scale Co.
Toledo Scale Co.
Torsion Balance Co.
Triner Sales Co.

SCALES, Classifying
Chatillon & Sons
Exact Weight Scale Co.
Jacobs Bros. Co., Inc.
Kron Co.
Merrick Scale Mfg. Co.
Toledo Scale Co.
Triner Sales Co.

SCALES Computing
Amtho. Testing Inst.
Exact Weight Scale
International Bus. Mach.
Jacobs Bros., Inc.
Toledo Scale Co.
Triner Sales Co.

SCALES, Continuous Weighing
Buffalo Scale Co.
Builders-Providence
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Gump Co.
Jacobs Bros. Co.
Jeffrey Mfg. Co.
Kron Co.
Merrick Scale Mfg. Co.
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.
Triangle Package Mach.
United Cinephone Corp.

SCALES, Conveyor
Builders-Providence
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Kron Co.
Merrick Scale Mfg. Co.
Richardson Scale Co.
Schaffer Poidometer Co.
Streeter-Amet Co.
Toledo Scale Co.

SCALES, Counting
Amthor Testing Inst. Co.
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
International Bus. Mach.
Jacobs Bros. Co.
Kron Co.
Seederer-Kohlbusch
Toledo Scale Co.
Triner Sales Co.
United Cinephone Corp.

SCALES, Crane
Buffalo Scale Co.
Chatillon & Sons
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Martin Decker Corp.

SCALES, Dairy
Becker, Inc., Christian
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Humboldt Mfg. Co.
International Bus. Mach.
Jacobs Bros. Co.
Kron Co.
Streeter-Amet Co.
Toledo Scale Co.
Torsion Balance Co.
Triner Sales Co.
Troemner, Henry

SCALES, Differential
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Jacobs Bros. Co., Inc.
Kron Co.
Thwing-Albert Instrument

SCALES, Drawing (See Drawing Instruments)

SCALES, Dump
Buffalo Scale Co.
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Toledo Scale Co.

SCALES, Dynamometer
Central Scientific Co.
Chatillon & Sons
Dillon & Co.
Exact Weight Scale
Fairbanks, Morse & Co.
Howe Scale Co.
Kron Co.
Martin Decker Corp.
Seederer-Kohlbusch, Inc.
Toledo Scale Co.

SCALES, Estimating
Exact Weight Scale Co.
Jacobs Bros. Co.
Seederer-Kohlbusch, Inc.
Troemner, Henry

SCALES, Grain & Seed Testing
Amthor Testing Inst. Co.
Automatic Scale Co.
Becker, Inc., Christian
Buffalo Scale Co.
Central Scientific Co.
Chatillon & Sons
Exact Weight Scale Co.
Fairbanks, Morse & Co.
Fisher Scientific Co.
Gump Co.
Howe Scale Co.
Jacobs Bros. Co.
Kron Co.
Newark Scale Works
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.
Torsion Balance Co.
Triangle Package Mach.
Triner Sales Co.
Troemner, Henry

SCALES, Hopper
Buffalo Scale Co.
Chatillon & Sons
Exact Weight Scale
Fairbanks, Morse & Co.
Gump Co.
Howe Scale Co.
Jacobs Bros. Co.
Kron Co.
Richardson Scale Co.
Streeter-Amet Co.
Toledo Scale Co.

KRON TEST INSTRUMENTS
•
Dial Type
WEIGHING EQUIPMENT

Fuel Flow Scales
Oil Flow Test Scales
Aircraft Cargo Scales
VICTORY IN '44
Dynamometer Scales
Control Cable Stretch & Strength Dynamometers
Aircraft Crane Scales
Magna-Pointer "Timed rate of flow" Test Scales
Spring Tension Inspection Scales
Counting Scales

THE KRON CO.
MAIN OFFICE & PLANT — BRIDGEPORT, CONN.
Offices in all principal cities

SCALES, Laboratory
- **Becker, Inc., Christian**
- **Buffalo Scale Co.**
- **Central Scientific Co.**
- **Chatillon & Sons**
- **Chicago Apparatus Co.**
- **Exact Weight Scale Co.**
- **Fairbanks, Morse & Co.**
- **Fisher Scientific Co.**
- **Howe Scale Co.**
- **Humboldt Mfg. Co.**
- **International Bus. Mach.**
- **Jacobs Bros. Co.**
- **Microchemical Service**
- **Newark Scale Works**
- **Seederer-Kohlbusch, Inc.**
- **Toledo Scale Co.**
- **Torsion Balance Co.**
- **Troemner, Henry**

SCALES, Larry Car
- **Buffalo Scale Co.**
- **Fairbanks, Morse & Co.**
- **Howe Scale Co.**
- **Kron Co.**
- **Richardson Scale Co.**
- **Streeter-Amet Co.**
- **Toledo Scale Co.**

SCALES, Liquid
- **Jacobs Bros. Co., Inc.**
- Merrick Scale Mfg.
- **Richardson Scale Co.**

SCALES, Loss of Weight
- **Becker, Inc., Christian**
- **Buffalo Scale Co.**
- **Exact Weight Scale Co.**
- **Jacobs Bros. Co.**
- **Kron Co.**
- **Seederer-Kohlbusch, Inc.**
- **Streeter-Amet Co.**
- **Toledo Scale Co.**
- **Torsion Balance Co.**

SCALES, Measuring
- **Automatic Scale Co.**
- **Howe Scale Co.**
- Kron Co.
- Richardson Scale Co.
- Triner Sales Co.

SCALES, Over & Under
- **Becker, Inc., Christian**
- Buffalo Scale Co.
- **Exact Weight Scale Co.**
- **Fairbanks, Morse & Co.**
- **Howe Scale Co.**
- International Bus. Mach.
- **Jacobs Bros. Co.**
- **Moisture Register Co.**
- **Streeter-Amet Co.**
- **Toledo Scale Co.**
- **Torsion Balance Co.**
- **Triner Sales Co.**
- **Troemner, Henry**

SCALES, Packaging
- **Automatic Scale Co.**
- **Becker, Inc., Christian**
- **Exact Weight Scale Co.**
- **Fairbanks, Morse & Co.**
- **Gump Co.**
- **Howe Scale Co.**
- **Kron Co.**
- **International Bus. Mach.**
- **Jacobs Bros. Co.**
- **Pneumatic Scale Corp.**
- **Richardson Scale Co.**
- **Toledo Scale Co.**
- **Torsion Balance Co.**
- **Triangle Package Mach.**
- **Triner Sales Co.**
- **Troemner, Henry**

SCALES, Platform
- **Becker, Inc., Christian**
- **Buffalo Scale Co.**
- **Chatillon & Sons**
- **Exact Weight Scale Co.**
- **Fairbanks, Morse & Co.**
- **Gump Co.**
- **Howe Scale Co.**
- **Humboldt Mfg. Co.**
- **International Bus. Mach.**
- **Knowles Scale Works**
- **Kron Co.**
- **Streeter-Amet Co.**
- **Toledo Scale Co.**
- **Torsion Balance Co.**
- **Triner Sales Co.**

SCALES, Portable
- **Black & Decker**
- **Buffalo Scale Co.**
- **Central Scientific Co.**
- **Chatillon & Sons**
- **Exact Weight Scale**
- **Fairbanks, Morse & Co.**
- Gump Co.
- Howe Scale Co.
- International Bus. Mach.
- **Jacobs Bros. Co.**
- **Knowles Scale Works**
- Kron Co.
- Richardson Scale Co.
- Toledo Scale Co.
- **Triner Sales Co.**

SCALES, Predetermined Weight
- **Becker, Inc., Christian**
- Buffalo Scale Co.
- **Exact Weight Scale Co.**
- **Fairbanks, Morse & Co.**
- Gump Co.
- Howe Scale Co.
- International Bus. Mach.
- Jacobs Bros. Co.
- **Merrick Scale Mfg. Co.**
- Richardson Scale Co.
- **Schaffer Poidometer Co.**
- **Seederer-Kohlbusch, Inc.**
- **Streeter-Amet Co.**
- **Toledo Scale Co.**
- **Torsion Balance Co.**
- **Triner Sales Co.**

SCALES, Recording
- **Buffalo Scale Co.**
- **Fairbanks, Morse & Co.**
- **Howe Scale Co.**
- **Kron Co.**
- **Merrick Scale Mfg. Co.**
- **Richardson Scale Co.**
- **Streeter-Amet Co.**
- **Toledo Scale Co.**
- **Wallace & Tiernan**

SCALES, Remote Indicating
- Merrick Scale Mfg.
- **Toledo Scale Co.**

SCALES, Rolling Mill
- Buffalo Scale Co.
- **Fairbanks, Morse & Co.**
- **Howe Scale Co.**
- Kron Co.
- Streeter-Amet Co.
- Toledo Scale Co.

SCALES, Sacking
(See Scales, Bag-filling)

SCALES, Selecting
- **Exact Weight Scale**
- Merrick Scale Mfg.
- **Toledo Scale Co.**
- **United Cinephone Corp.**

SCALES, Solder Test
- **Central Scientific Co.**
- **Exact Weight Scale**
- **Seederer-Kohlbusch, Inc.**
- **Troemner, Henry**

SCALES, Steel
- **Exact Weight Scale**
- **Fairbanks, Morse & Co.**
- Howe Scale Co.
- Kron Co.
- **Lufkin Rule Co.**
- Streeter-Amet Co.
- Toledo Scale Co.

SCALES, Testing
- **Becker, Inc., Christian**
- Buffalo Scale Co.
- **Chatillon & Sons**
- **Exact Weight Scale**
- Gump Co.
- Howe Scale Co.
- Humboldt Mfg. Co.
- Jacobs Bros. Co.
- Kron Co.
- **Newark Scale Works**
- Toledo Scale Co.
- **Torsion Balance Co.**

SCALES, Textile
- **Becker, Inc., Christian**
- Buffalo Scale Co.
- Exact Weight Scale Co.
- **Fairbanks, Morse & Co.**
- Howe Scale Co.
- International Bus. Mach.
- Kron Co.
- Saxl Instrument Co.
- **Seederer-Kohlbusch, Inc.**
- **Streeter-Amet Co.**
- **Suter, Alfred**
- **Toledo Scale Co.**
- **Torsion Balance Co.**
- Triner Sales Co.

SCALES, Track
- Buffalo Scale Co.
- **Fairbanks, Morse & Co.**
- Howe Scale Co.
- Kron Co.
- Streeter-Amet Co.
- Toledo Scale Co.

SCALES, Truck
- Black & Becker
- Buffalo Scale Co.
- Exact Weight Scale Co.
- **Fairbanks, Morse & Co.**
- Howe Scale Co.
- Streeter-Amet Co.
- Toledo Scale Co.

SCALES, Water Meter
- Altender & Sons
- **Exact Weight Scale**
- **Fairbanks, Morse & Co.**
- **Jacobs Bros. Co.**
- Kron Co.
- Toledo Scale Co.

SCALES, Yardage
- **Amthor Testing Inst.**
- Brown & Sharpe
- Buffalo Scale Co.
- **Exact Weight Scale**
- **Fairbanks, Morse & Co.**
- Howe Scale Co.
- International Bus. Mach.
- Kron Co.
- Toledo Scale Co.

SCREENS, Solar Projecting
- **Fecker, J. W.**

SCREENS, X-Ray Fluoroscopic
- General Electric X-Ray
- Kelley-Koett Mfg. Co.
- Patterson Screen Co.
- Westinghouse X-Ray Co.

SCREENS, X-Ray Intensifying (See Screens X-Ray Fluoroscopic)

SEED SIEVE SETS
- **Ballauf Mfg. Co.**

SEGER CONES (See Cones, Pyrometric)

SEISMOGRAPHS
- Akatos, Inc.
- Alpha Instrument Co.
- **American Inst. Co.**
- Am. Telescope Labs.
- **Consolidated Engg.**
- Engineering Labs., Inc.
- **Geophysical Instrument**
- **Heiland Research Corp.**
- Mico Instrument Co.
- **Miller Corp., Wm.**

SELF-OPERATING CONTROLLERS & REGULATORS, AUTOMATIC
- **Am. Automatic Elec.**
- **American Inst. Co.**
- **Area Regulators, Inc.**
- **Bailey Meter Co.**
- Bastian-Blessing
- Belfield Co
- **Betts & Betts**
- Brooke Engineering
- **Brown Inst. Co.**
- Cutler-Hammer, Inc.
- D'Este Co.
- **Dickson Co.**
- Elec. Indicator Corp.
- **Fischer & Porter**
- Hanlon-Waters, Inc.
- Lammert & Mann Co.
- **Leeds & Northrup Co.**
- Leslie Co.
- Leupold & Stevens
- **Mason-Neilan Regulator**
- **Minneapolis-Honeywell**
- **Partlow Corp.**
- Penn Electric Switch Co.
- Perfex Corp.
- **Ruggles-Klingemann**
- **Scientific Inst. Co.**
- **Tagliabue Mfg. Co.**
- **Taylor Inst. Cos.**
- **United Transformer**
- **Wheelco Instruments**

SERVO-MOTORS, Electric Motor
- **Brown Inst. Co.**
- Eclipse Aviation
- General Regulator Corp.
- **L. A. B. Corp.**
- **Minneapolis-Honeywell**

SERVO-MOTORS, Electric Solenoid
- **Brown Inst. Co.**
- Eclipse Aviation
- Ruggles-Klingemann

SERVO-MOTORS, Hydraulic
- Adel Precision
- **Askania Regulator Co.**
- Eclipse Aviation
- General Regulator Corp.
- Hagan Corp.
- **Mason-Neilan Regulator**
- Ruggles-Klingemann

SERVO-MOTORS, Mechanical
- Hagan Corp.

SERVO-MOTORS, Pneumatic
- **Askania Regulator Co.**
- **Brown Inst. Co.**
- Hagan Corp.
- **Mason-Neilan Regulator**
- **Minneapolis-Honeywell**

SEXTANTS
- Alpha Instrument Co.
- **Bausch & Lomb Opt.**
- Kern Co.
- Keuffel & Esser Co.
- Kuner Co., Max
- Link Aviation Devices
- **Master Optical Co.**
- Negus, T. S. & J. D.
- Pioneer Instrument Co.
- **Roth Brothers**
- Warren-Knight Co.
- White Co., Inc.

SHIP LOGS
- **Elec. Tachometer Corp.**
- Kenyon Instrument Co.
- Negus, T. S. & J. D.
- Pitometer Log Corp.

SHUNT METERS (See Meters, Shunt)

SHUNTS
- **Associated Research**
- **Burton-Rogers Co.**
- Cole Instrument
- **Columbia Elec. Mfg.**
- **De Jur-Amsco**
- **Esterline-Angus Co.**
- **General Elec. Co.**
- **Hickok Elec. Inst. Co.**
- **International Resistance**
- **Precision Resistor Co.**
- **Radio City Products Co**
- **Rawson Electrical Inst.**
- **Roller-Smith Co**
- **Rubicon Co.**
- **Sensitive Research Inst.**
- **Shallcross Mfg.**
- Sun Manufacturing
- **Triplett Electrical Inst.**
- **Westinghouse Elec. & Mf**
- **Weston Elec. Inst. Cor**

SHUNTS, Standard
- **Cambridge Instrument Co**
- Cole Instrument
- **De Jur-Amsco**
- **Esterline-Angus Co.**
- **General Electric Co.**
- **Gray Instrument Co.**
- **Hickok Electrical Inst.**
- **Instrument Resistors, Inc**
- **International Resistance**
- **Leeds & Northrup Co.**
- **Roller-Smith Co.**
- **Rubicon Co.**
- **Shallcross Mfg.**
- **Triplett Elec. Inst. Co.**
- **Weston Elec. Inst. Corp.**

SIEVE SHAKERS
- Braun Corp.
- Newark Wire Cloth
- **Precision Scientific**

SIEVES, TESTING
- **American Inst. Co.**
- Central Scientific Co.
- **Dietert Co.**
- **Fisher Scientific Co.**
- Humboldt Mfg. Co.
- Newark Wire Cloth
- **Precision Scientific Co.**
- **Riehle Division**
- **Scientific Inst. Co.**
- **Weber Brothers Metal**

SIGHT FEED BUBBLERS
- **Meriam Co.**

SIGHT METERS
- **De Jur-Amsco**
- **General Elec. Co.**
- **G-M Labs.**
- **Triplett Elec. Inst.**
- **Weston Elec. Inst. Corp**

SIGHTS, GUN, Telescopi
- **Bausch & Lomb Opt.**
- Bell & Howell Co.
- Buhl Optical
- Clark & Sons
- **Fecker, J. W.**
- Kollmorgen Optical Co.
- **Perkin-Elmer Corp.**
- Stafford Co.
- Zeiss, Inc., Carl

SIGNAL GENERATORS (See Generators, Signal)

SIGNALING DEVICES, Automatic
- American Automatic Elec.
- Autocall Co.
- **Betts & Betts**
- Bullard Co.
- Cincinnati Time Rec.
- Elec. Indicator Corp.
- **Foxboro Co.**
- **General Elec. Co.**
- **Guardian Elec. Mfg. Co.**
- **Holtzer-Cabot Elec. Co.**
- International Bus. Mach.
- Leslie Co.
- Leupold & Stevens
- National Time & Signal
- Production Instrument
- Spence Engineering Co.
- **Thompson Clock Co.**
- United Cinephone Corp
- **Warren Telechron**
- **Wheelco Instruments**

SIGNALING DEVICES, Traffic
- **Am. Gas Accumulator**
- Bullard Co.
- Eagle Signal Corp.
- **Edison Electrical Controls**
- National Time & Signal
- Sangamo Electric Co

SILICA, VITREOUS
- **Thermal Syndicate, Ltd.**

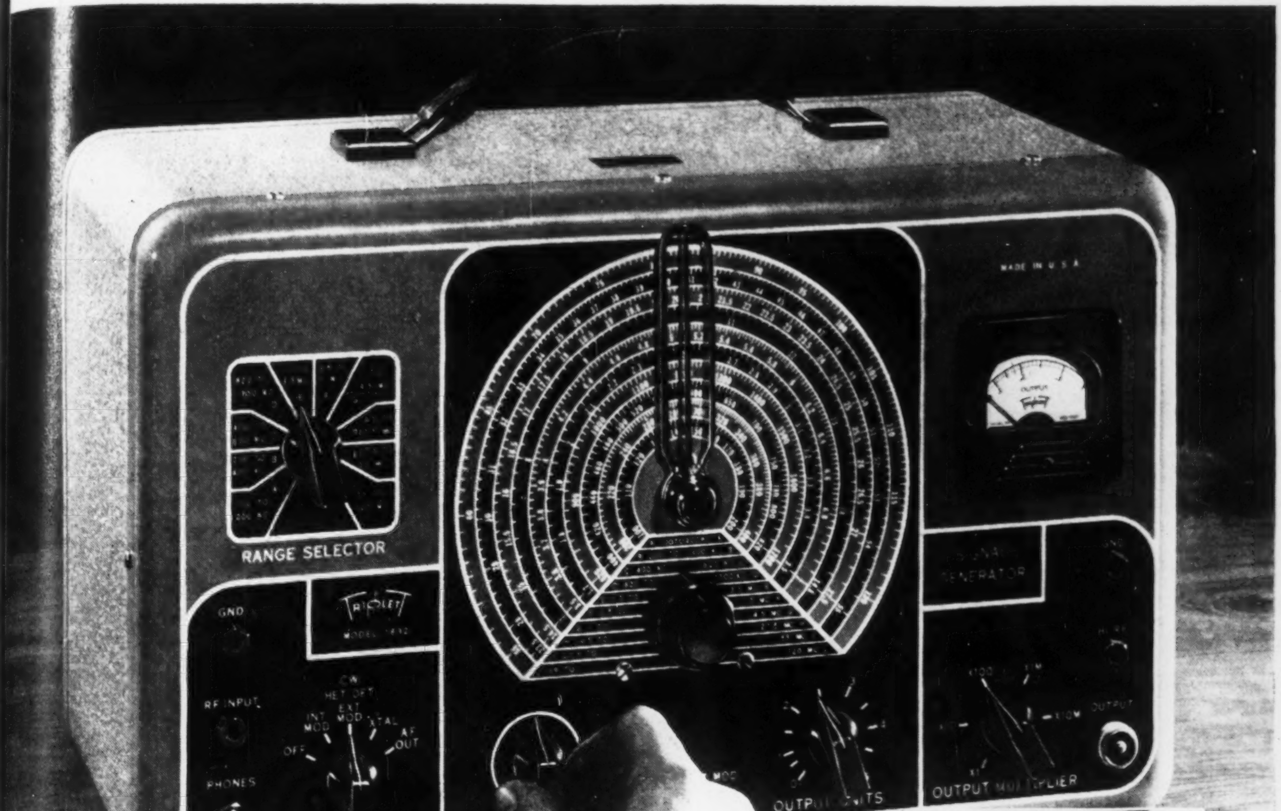
SINE BARS
- **Ford Motor Co.**
- Herkimer Tool
- Jansson Gage Co.
- Thomas Tool

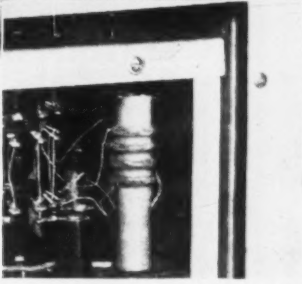
SLIDE RULES (See Drawing Instruments)

SLIDING GAGES (See Gages, Sliding)

SLOW MOTION STUDY EQUIPMENT
- Annis Co.
- **Boulin Instrument Corp.**
- **Commercial Engg. Labs.**
- Warren Telechron Co.

SLUMP CONES (See Cones, Slump)


MADE IN U.S.A.
RANGE SELECTOR
TRIPLETT
MODEL 1632
SIGNAL GENERATOR
GND
RF INPUT
PHONES
CIRCUIT SELECTOR
OUTPUT UNITS
OUTPUT MULTIPLIER
OUTPUT


• Triple shielding throughout. Steel outer case, steel inner case, plus copper plating.

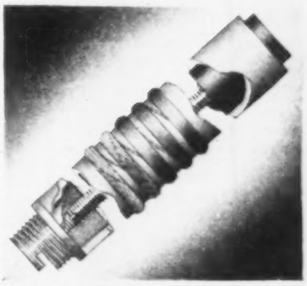
ODEL NO. 1632

Signal Generator

CONTINUOUS COVERAGE — 100 KC. TO 120 MC. • ALL FREQUENCIES FUNDAMENTALS

A complete wide-range Signal Generator in keeping with the broader requirements of today's testing. Model 1632 offers accuracy and stability, beyond anything heretofore demanded in the test field, plus the new high frequencies for frequency modulated and television receivers, required for post-war servicing. Top-quality engineering and construction throughout in keeping with the pledge of satisfaction represented by the familiar Triplett trademark.

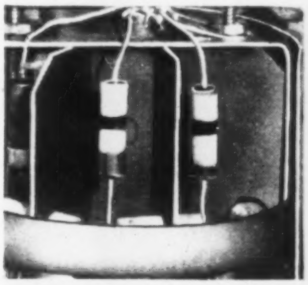
Of course today's production of this and other models go for war needs, but you will find the complete Triplett line the answer to your problems when you add to your post-war equipment.

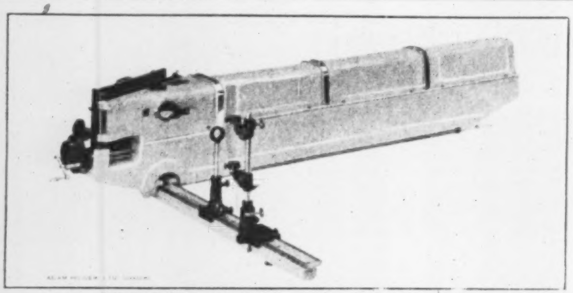

• All coils permeability tuned. Litz wire wound impregnated against humidity with "high-Q" cement.

Triplett

ELECTRICAL STANDARDS ARE SET BY TRIPLETT **INSTRUMENT CO.**

BLUFFTON OHIO ★ ★ ★


• Note sections individually shielded with pure copper. Entire unit encased in aluminum shield.



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Photobell Corp.
Photoswitch Inc.
Photovolt Corp.
Preferred Utilities Mfg.
Rehtron Corp.
United Cinephone Corp.
Weston Elec. Inst. Corp.
Worner Products

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SOLAR PROJECTING SCREEN (See Screen, Solar Projecting)

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Daven Co
Jur-Amsco Corp.
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General Radio Co.
Meters, Inc.
Precision Apparatus Corp.
Radio City Products Co.
Shallcross Mfg. Co.
Sound Apparatus Co.
Triplett Electrical Inst.
Waugh Laboratories
Western Electric
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

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Bliss & Co.
Kenyon Instrument Co
Kuner Co., **Max**
Moeller Instrument Co.
Negus, T. S & J. D.

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Bendix Marine Products
Kenyon Instrument **Co.**
Kuner Co., **Max**
Moeller Instrument Co.
Negus, T S & J. D.
Stafford Co.
Submarine **Signal** Co.

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Kimble Glass Co.
Moeller Instrument Co.
Negus, T. S. & J. D.

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Moore Products
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Trerice Co.

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Fuess, Inc.
Gaertner Scientific Corp.

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Baird Associates
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Bryden Co
Gaertner Scientific Corp.
Jarrell-Ash
Spencer Lens Co.
Zeiss, Inc., Carl

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Applied Research **Labs.**
Baird Associates
Dearborn Scientific
Jarrell-Ash Co.

SPECTROGRAPHS, Oscillating
Hayes Scientific App.

SPECTROGRAPHS, Vacuum
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Dietert Co.
Fecker, J. W.
Fuess, Inc.
Jarrell-Ash Co.

SPECTROGRAPHS, X-ray
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Fuess, Inc.
Gaertner Scientific
General Electric X-Ray
Hayes Scientific App.
Jarrell-Ash Co.
Kelley-Koett Mfg.

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Bausch & Lomb Optical
Dearborn Scientific
Fuess, Inc.
Gaertner Scientific
Jarrell-Ash Co.
Spencer Lens Co.

SPECTROMETERS, Recording Mass
Consolidated Engg.

SPECTROMETER, Infra-Red
Gaertner Scientific Corp.
Jarrell-Ash Co.

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SPECTRO-PHOTOMETERS (See Photometers, Spectro)

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Bausch & Lomb Opt.
Dearborn Scientific
Fish-Schurman Corp.
Fuess, Inc.
Gaertner Scientific Corp.
Laboratory Specialties
Leitz, Inc.
Spencer Lens Co.

SPECTROSCOPE, Quartz
Gaertner Scientific Corp

SPECTROSCOPES, Stellar
Am. Telescope **Labs.**
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Eastern Science Co.
Fecker, J. W.
Mico Instrument Co.
Perkins-Elmer Corp.
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Fuess, Inc.
Gaertner Scientific Corp.
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Metron Instrument
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Westinghouse Elec. **& Mfg.**
Weston Elec. Inst. Corp.
Zernickow Co., O.

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Corbin Screw Corp.
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General Elec.
Jones-Motrola
Knopf, Paul
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Westinghouse Elec. & Mfg.
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Ferner Co.
Fish-Schurman Co.
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Gaertner Scientific Corp.
Merkle Korff Gear
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Hellige, Inc.
Precision Thermometer
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Lufkin Rule Co
Jansson Gage Co.
Mico Instrument Co
Starrett Co
Thomas Tool
Union Tool Co
Warren-Knight Co.

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General Radio Co.
Industrial Instruments
Leeds & Northrup Co.
Rubicon Co.
Solar Mfg. Corp

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Hellige, Inc.
Munsell Color Co
Tagliabue Mfg. Co.

STANDARDS E.m.f.
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Espey Mfg.
Leeds & Northrup Co.
Rubicon Co.

STANDARDS, Frequency
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Andrew Victor J.
Espey Mfg.
Ferris Inst. Corp.
General Radio Co.
RCA Manufacturing
Warren Telechron Co

STANDARDS, Inductanc
Cambridge Inst. Co.
General Radio Co.
Leeds & Northrup Co.
Rubicon Co.

STANDARDS, Length
Gaertner Scientific Cor
Gurley, W. & L. E.
Van Keuren Co.

STANDARDS, Mass
Gurley, W. & L. E.
Seederer-Kohlbusch, Inc.

STANDARDS, Potential
Leeds & Northrup Co.
Rubicon Co.

STANDARDS, Pressure
Green, Henry J.
Precision Therm.

STANDARDS, Resistanc
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Cambridge Inst. Co.
General Radio Co.
International Resistance
Leeds & Northrup Co.
Rubicon Co.
Shallcross Mfg. Co.
Sticht & Co.
Ward Leonard Elec. Co.

STANDARDS, Sound Lev
General Radio Co.

STANDARDS, Temperatu
Green, Henry J.
Leeds & Northrup Co.
Moeller Instrument Co.
Precision Therm.
Tagliabue Mfg. Co.

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Gaertner Scientific Cor
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Standard Elec. Time Co
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Eclipse Aviation
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Stocks are limited—due to our facilities being used in making special precision instruments for the U. S. Government—but priority orders are being accepted, and filled, as quickly as possible.

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Pioneer Instrument
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Westinghouse Elec. & Mfg.
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Beckman Co.
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Shallcross Mfg. Co.
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Cramer & Co., Inc.
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General Elec. Co.
Hart Mfg. Co.
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SWITCHES, Instrument
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Autocall Co.
Automatic Electric
Barber-Colman
Federal Anti-Capacity
Furnas Electric Co.
General Elec. Co.
J-B-L Inst. Co.
Kellogg Switchboard
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Sensitive Research Inst.
Shallcross Mfg.
Thwing-Albert Instrument
Triplett Elec. Inst. Co.
United States Inst. Corp.
Utah Radio Prods.
Westinghouse Elec. & Mfg.
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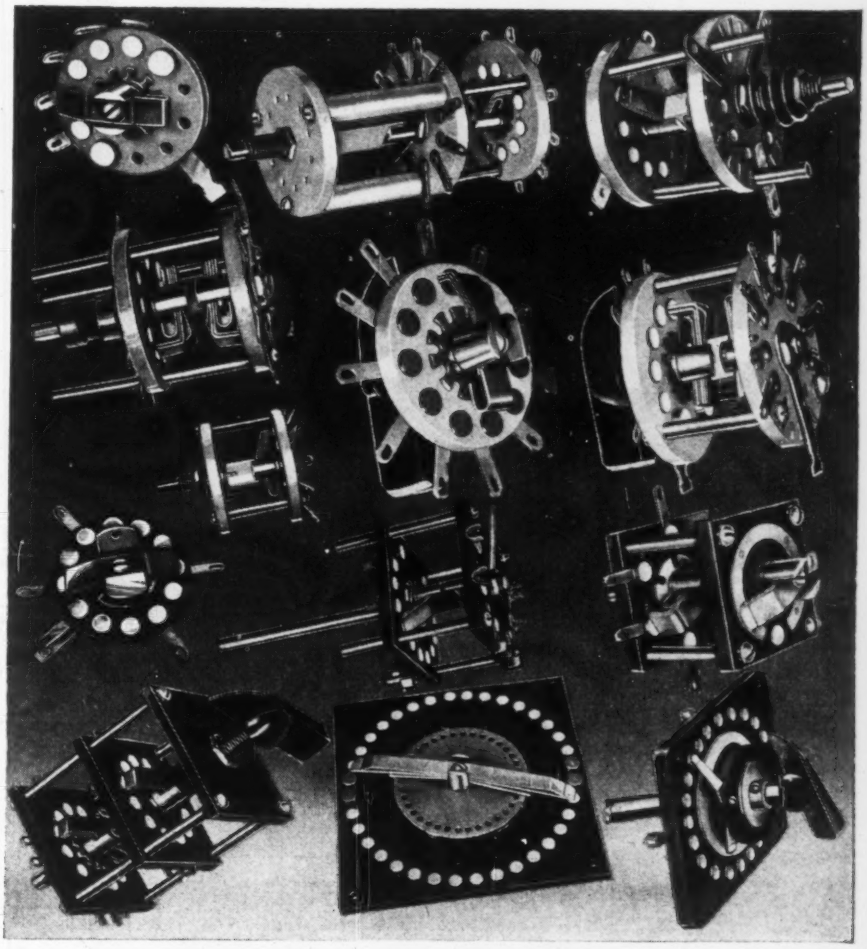

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SELECTOR SWITCHES

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Decade Resistance Boxes
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and many more

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Shallcross Selector Switches are the logical outgrowth of our own need for dependable, high-quality units for exacting Shallcross electrical measuring devices and other equipment. You'll find them unexcelled for use wherever the call is for switches of assured better performance.

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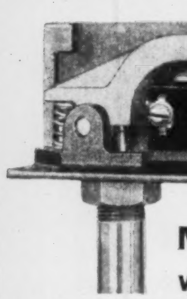
ENGINEERING · DESIGNING · MANUFACTURING
Dept. IS-24 Collingdale, Pa.

BURLING
TEMPERATURE
LIMIT SWITCHES

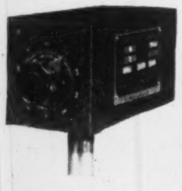


MODEL H
WITH MANUAL
RESET BUTTON

Improved High Temperature Safety Switch with Manual Reset Button. Available with switch normally closed for cutting off heat, stopping fan, closing valve—with switch normally open for lighting lamp or ringing bell — with single pole double throw switch . . . breaks heating circuit while closing alarm circuit. Sturdy, foolproof reset button operates from outside of case.

- Accurate, Rugged, Dependable
- Corrosion and heat resisting tube
- Dial Pointer for easy setting
- Locking screw locks temperature setting
- Terminal plate has large screw terminals.
- Snap-action Micro-Switch eliminates contact troubles
- Range 0-1400°F. Adjustable range 200-300°F
- Dimensions—5⅛" x 1¾" x 3"

MODEL D



For use where temperatures must be changed to suit operating conditions. Turn outside knob to change temperature setting. Simple in design . . . accurate and dependable under severest operating conditions. Temperature range 0-1400°F. Standard adjustable range 200-500°F. Single snap action switch. (Dimensions: 5½" x 2¾" x 2¾")

Instruments also Built to Specifications

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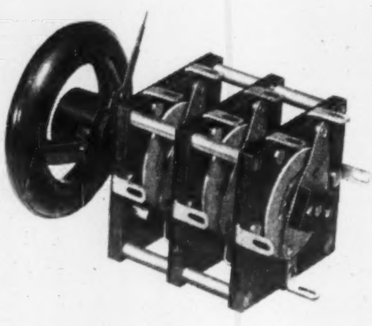
251C Springfield Ave.
Newark. N. J.

-COLE-
Multi-Deck Switches



Here is a compact, heavy-duty switch that provides a large number of contacts in small space. It is furnished in one to six decks with a maximum of 23 contacts and off position per deck making possible up to 138 contacts with a six deck unit. The illustration above shows a three deck unit. Current carrying capacity up to 25 amperes. Has fabric bakelite base 3 inches overall. Solid silver contacts. Lugs and all other metal parts are silver-plated. Furnished either with or without knob or handwheel.

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Penn Electric Switch
Perfex Corp.
Struthers-Dunn
Ward Leonard Elec. Co.
Warrick, C. F.
Zenith Electric Co.

SWITCHES, Mercury
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Bacon Electric Timer
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Elec. Switch Corp.
Frederick, George
General Elec. Co.
Gen. Elec. Lamp Dept.
Hart Mfg. Co.
Minneapolis-Honeywell

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Cutler-Hammer, Inc.
Echo Electrical
Mallory & Co.
Utah Radio Prods.

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Cole Instrument
J-B-T Insts. Inc.
Lewis Engg. Co.
Rowe Research Lab.
Tagliabue Mfg. Co.
Thwing-Albert Inst. Co.
Triplett Elec. Inst.
Weston Elec. Inst. Corp.
Wheelco Instruments

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Andrew, Victor J.
Amer. Automatic Elec.
Arrow-Hart & Hegeman
Autocall Co.
Automatic Switch Co.
Betts & Betts
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(Cont'd)

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(Cont'd)
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Eclipse Aviation
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Friez & Sons
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Guardian Elec. Mfg. Co.
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Kellogg Switchboard
Mallory & Co.
Monitor Controller Co.
Penn Electric Switch
Perfex Corp.
Struthers-Dunn
Ward Leonard Elec. Co.
Zenith Electric Co.

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Autocall Co.
Barber-Coleman
Cole Instrument
Daven Co.
Furnas Electric Co.
General Elec. Co.
Guardian Elec. Mfg. Co
Hart Mfg. Co.
J-B-T Insts.
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Mallory & Co.
Ohmite Mfg. Co.
Roller-Smith Co.
Rubicon Co.
Sensitive Research Inst.
Shallcross Mfg. Co.
Tagliabue Mfg. Co.
Thwing-Albert Inst. Co.
Triplett Electrical Inst.
Utah Radio Prods.
Weston Elec. Inst. Corp.

SWITCHES, Snap
Arrow-Hart & Hegeman
Cutler-Hammer, Inc.
General Elec. Co.
Hart Mfg. Co.
Mallory & Co.
McDonnell & Miller
Micro Switch Corp.
Minneapolis-Honeywell
Perfex Corp.
Ward Leonard Elec. Co.

SWITCHES, Snap Action
Acro Electric
Micro Switch
Mu-Switch Corp.

MERCOID HERMETICALLY SEALED SWITCHES
VISAFLAME
LIGHT ACTUATED TYPE
MERCOID SWITCH FIG. NO. 9-81
MAGNET TYPE
MERCOID
TILTING TYPE

MERCURY
SWITCHES
by
MERCOID

Mercury switches are the most advanced means for "making" and "breaking" an electrical circuit. They are not affected by dust, dirt or corrosion and have many definite applications where open contacts are not suitable ★ SPECIFY MERCOID it is your guarantee of the best obtainable in mercury switches.

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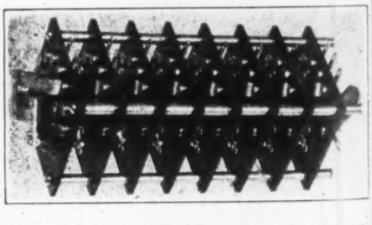
J-B-L INSTRUMENT CO.
Manufacturers of
ROTARY SWITCHES
for
INSTRUMENT, ELECTRICAL AND
INDUSTRIAL APPLICATIONS



Low and positive contact resistance, indexing mechanism, multi-deck, multi-contact, shorting, non-shorting, rugged and dependable.

Submit Your Switch Problem

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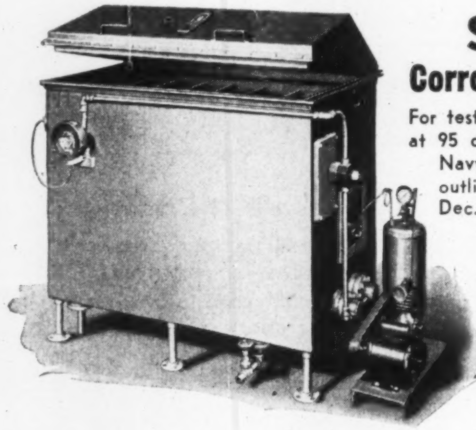

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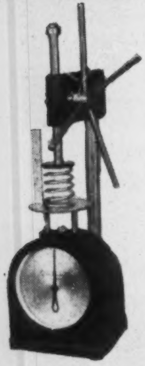

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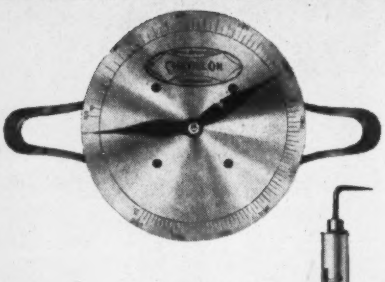

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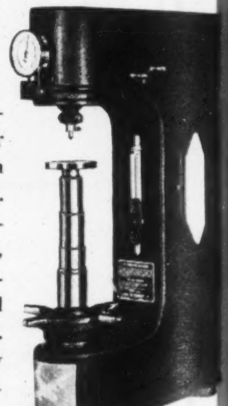

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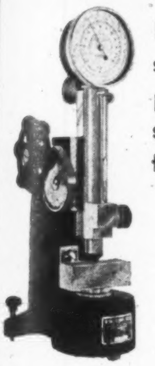

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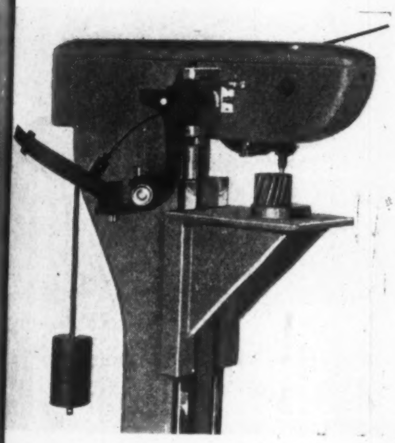

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TESTERS & TESTING MACHINES, Deflection, Light Wave
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Refinery Supply Co.
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Instrument Specialties

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Saxl Inst. Co.
Scott Co., Henry L.
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Suter, Alfred

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Ferner Co.
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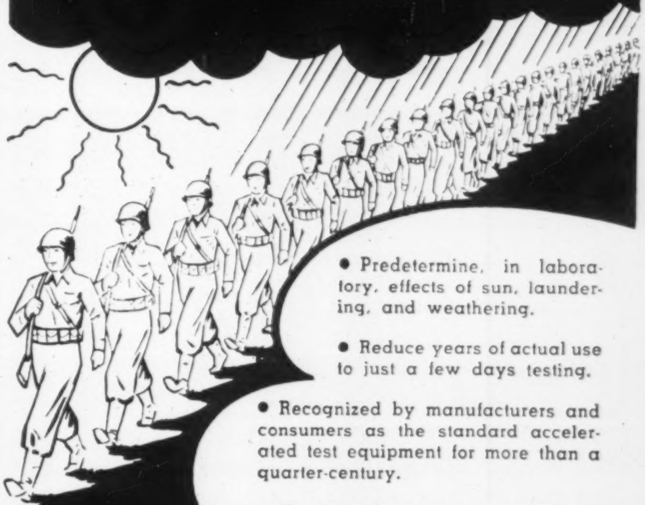

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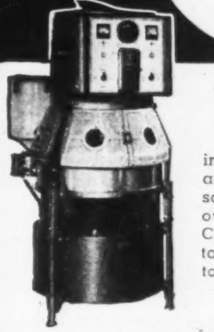

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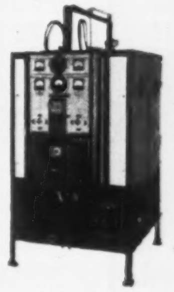

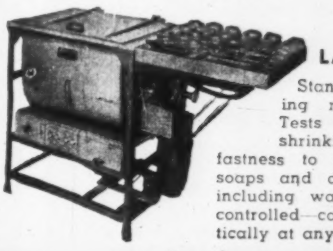

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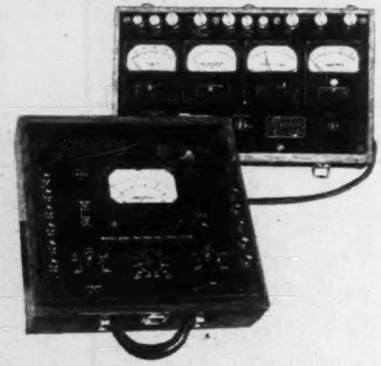

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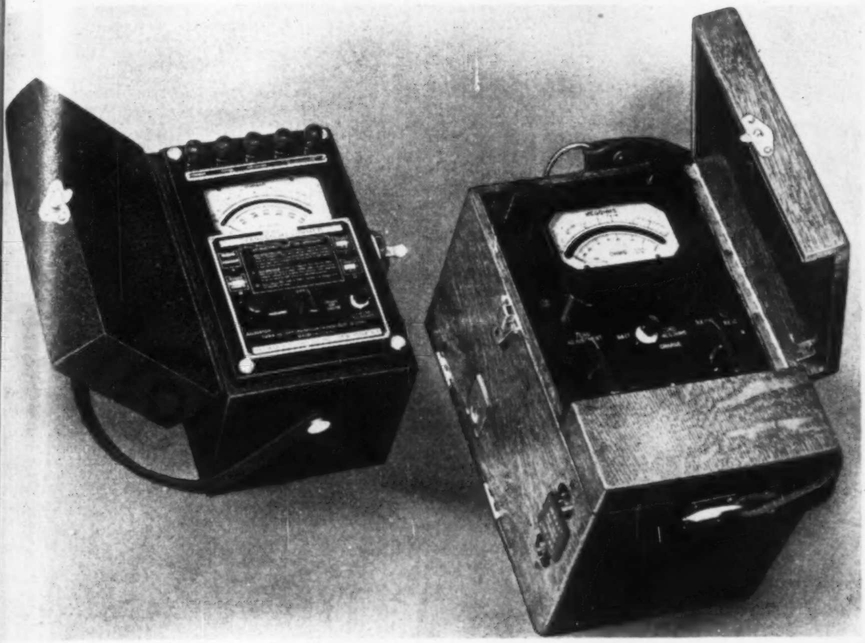

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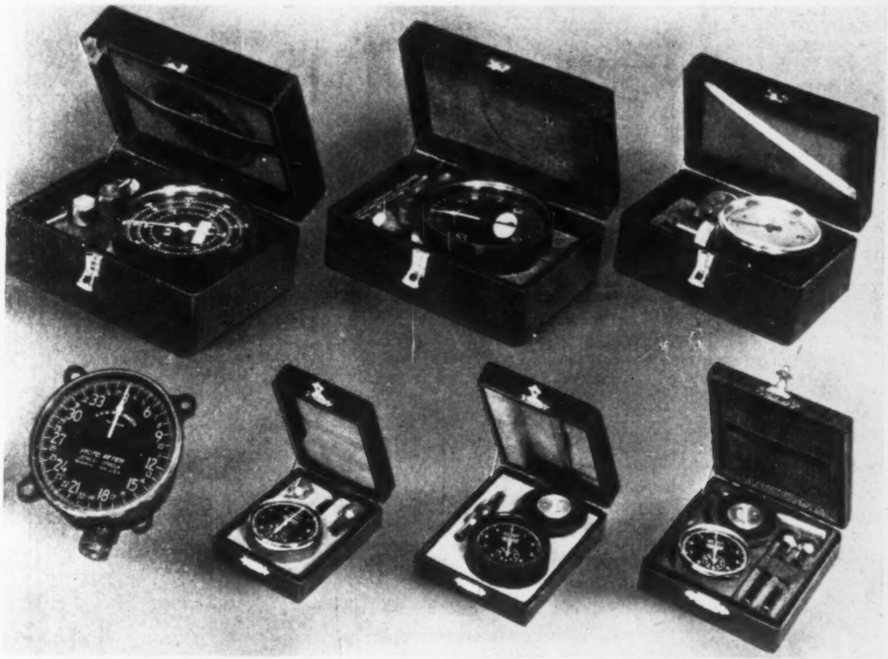

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for Chronometric Type
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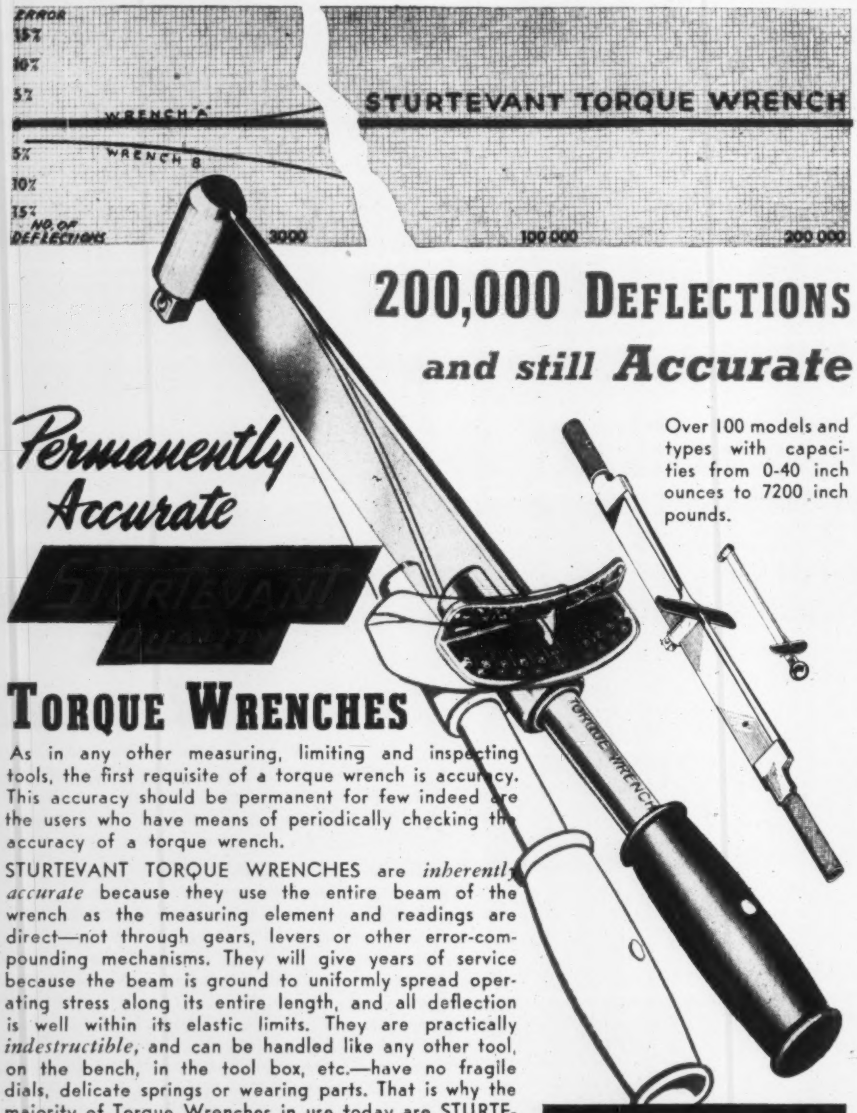

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See page 126

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General Elec Co.
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Pioneer Instrument
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Rubicon Co.

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Rieker Instrument Co.

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(See Meters, Mileage)

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Ruehfel Co.
Scientific Glass App.
Testrite Instrument Co.
Tagliabue Mfg. Co.

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American Inst. Co.
American Moistening Co.
Brabender Corp.
Cambridge Inst. Co.
Central Scientific Co.
Cuthbert Co.
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Dietert Co.
Eimer & Amend
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Fuess, Inc.
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Sodeman Heat & Power
Tagliabue Mfg. Co.
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Thwing-Albert Inst. Co.
Toledo Scale Co.
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Central Scientific Co.
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Mico Instrument Co.
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Ruehfel Co.
Ruska & Co.
Scientific Glass App.
Scientific Inst. Co.
Tagliabue Mfg. Co.
Western Machinery Co.

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Burrell Technical Supply
Eimer & Amend
Sargent & Co.
Scientific Glass App.
Scientific Inst. Co.
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Atlas Elec. Devices Co.
Central Scientific Co.
Fish-Schurman Co.
Munsell Color Co.
Photovolt Corp.
Ruehfel Co.
Saxl Instr. Co.
Scott Co., Henry L.
Taber Instrument Co.
Van Keuren Co.
Zuhr, Inc., Henry

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Amthor Testing Inst. Co.
Atlas Elec. Devices
Central Scientific Co.
Dillon & Co.
Eimer & Amend

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Olsen Testing Machine
Perkins & Son
Photovolt Corp.
Riehle Div.
Saxl Inst. Co.
Scott Co., Henry L.
Speidel & Co.
Steel City Testing
Taber Instrument Co.
Toledo Scale Co.
Van Keuren Co.
Williams Apparatus Co.

TESTERS & TESTIN MACHINES, Pap Formation
Fuess, Inc.
Paprex Co.
Saxl Inst. Co.
Thwing-Albert Inst. Co.
Williams Apparatus Co.

TESTERS & TESTIN MACHINES, Paraffin
American Inst. Co.
Perkins & Son
Ruehfel Co.
Tagliabue Mfg. Co.

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Saxl Inst. Co.
Testing Machines, Inc.
Thwing-Albert Inst. Co
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Taylor & Co., W. A.

TESTERS & TESTIN MACHINES, Pipe Tube
Baldwin-Southwark Cor
Black & Decker
Dillon & Co.
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Kollmorgen Optical Co.
Lenox Inst. Co.
Scherr Co., Inc.

TESTERS & TESTIN MACHINES, Pist Ring

TESTERS & TESTIN MACHINES, Pitch
American Inst. Co.
Precision Scientific Co.

TESTERS & TESTIN MACHINES, Plastici
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Brabender Corp.
Dietert Co.
Dillon & Co.
Eimer & Amend
Olsen Testing Machine
Precision Scientific Co.
Saxl Inst. Co.
Scott Co., Henry L.
Steel City Testing
Testing Machines, Inc.

TESTERS & TESTIN MACHINES, Porosity
Fuess, Inc.
Gurley, W. & L. E.
Ruska & Co., Inc.
Saxl Inst. Co.
Testing Machines, Inc.
Williams Apparatus Co.

TESTERS & TESTIN MACHINES, Pulp
Brabender Corp.
Perkins & Son
Testing Machines, Inc.
Williams Apparatus Co.

TESTERS & TESTIN MACHINES Radio S
Boes Co., W. W.
Communication Meas. Lab
Dayton Acme Co.
Ferris Instrument Corp.
General Test Equip.
Hewlett-Packard
Hickok Electrical Inst.
Industrial Instruments
Measurements Corp.
Million Radio & Televisio
Monarch Manufacturing
RCA Manufacturing
Shallcross Mfg. Co.
Supreme Instrument Corp
Triplett Electrical Inst.
Westinghouse Elec. & Mfg
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←BASIS WEIGHT SCALES

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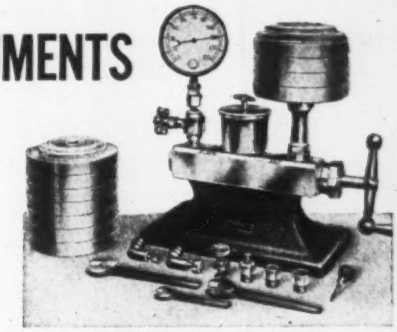
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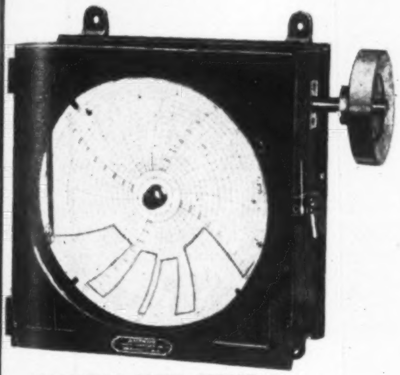
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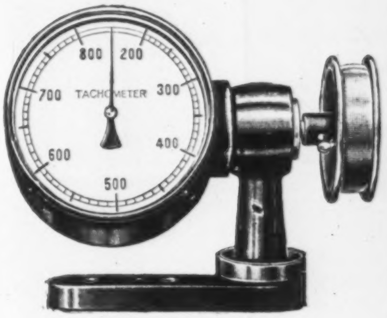

(Centrifugal type)
STATIONARY TACHOMETERS

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Cole Instrument
Communication Meas. Lab.
Gray Instrument Co.
Industrial Instruments
Leeds & Northrup Co.
Million Radio & Tele.
RCA Manufacturing
Readrite Meter Wks.
Rubicon Co.
Shallcross Mfg. Co.
Supreme Instrument Corp.
Triplett Electrical Inst.
Westinghouse Elec. & Mfg.
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Dillon & Co.
Eimer & Amend
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Ferner Co.
Fish-Schurman Co.
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Olsen Testing Machine
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Riehle Div.
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Shore Instrument
Suter, Alfred
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Dietert Co.
Eimer & Amend
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Humboldt Mfg. Co.
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Dietert Co.
Saxl Inst. Co.
Spencer Lens Co.
Steel City Testing
Taber Instrument Co.
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Baldwin-Southwark Corp.
Olsen Testing Machine
Riehle Div.
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Suter, Alfred

TESTERS & TESTING MACHINES, Sheet Metal
Baldwin-Southwark Corp.
Bock Machine Co.
Detroit Testing Mach.
Dillon & Co.
Krouse Fatigue Machine
Olsen Testing Machine
Riehle Div.
Scott Co., Henry L.
Steel City Testing
Suter, Alfred
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Saxl Inst. Co.
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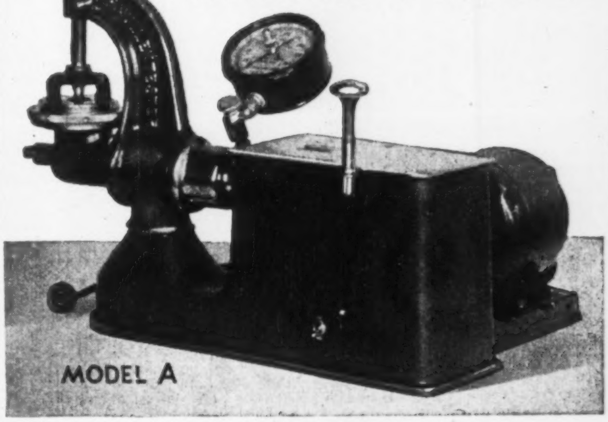

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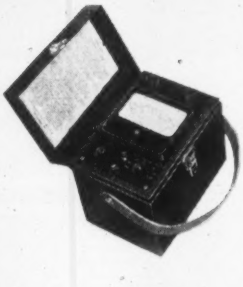

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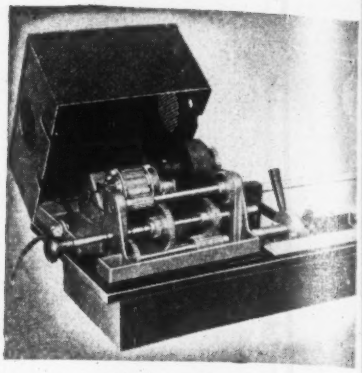

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Suter, Alfred

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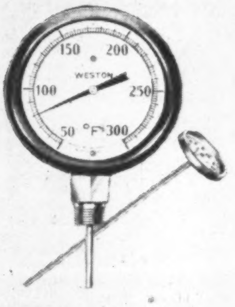
ALL-METAL
THERMOMETERS



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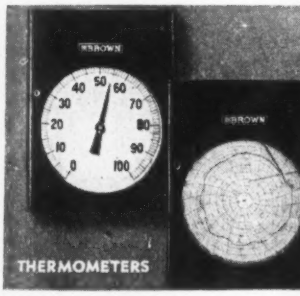

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TESTING SIEVES
See Sieves, Testing

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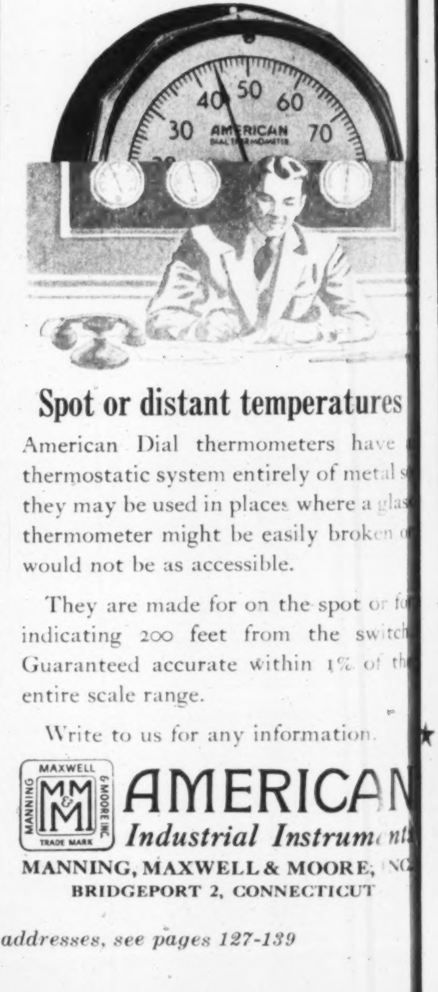

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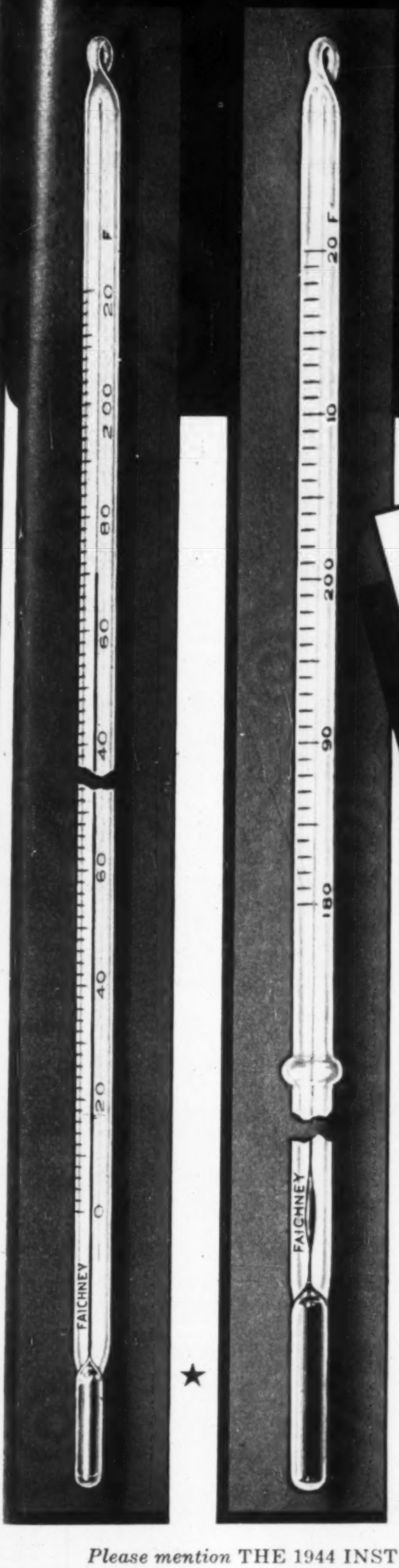
CHEMICAL AND LABORATORY

THERMOMETERS



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FAICHNEY INSTRUMENT CORPORATION

Watertown, N. Y.

America's largest producer of solid glass etched stem thermometers.

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THERMOCOUPLES
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Gasket, Bayonet and Blind Rivet types. Calibrated lead wires of either copper-constantan or iron-constantan. A N and NAVY connectors and switches.

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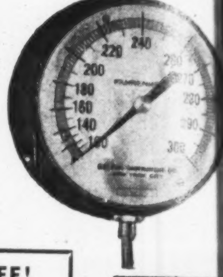

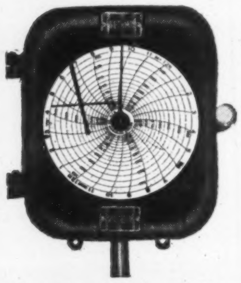

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DIAL THERMOMETERS
Mercury, Vapor and Gas actuated types
3½", 4½", 6", and 8½" Diameters, Dust, Fume and Moisture Proof. Wall or Flush Mounted.

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6", 10", and 12" recording charts—Simple to operate. Quick, easy "one hand" chart changing.

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Straight and Angle Form Types with Red-Reading mercury.
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7", 9", and 12"

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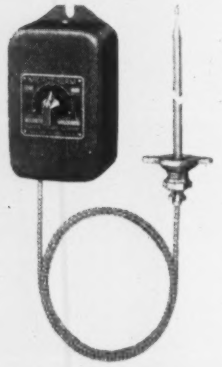

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REMOTE-BULB THERMOSTATS and MICROTHERMS

Sensitive, rugged, accurate insertion-type instruments for operating control systems from small changes of temperature in vats, tanks, pipes, etc. Write for complete data sheets.

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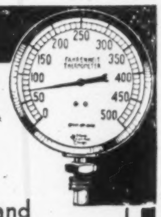

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Thermometers

The Marsh line of dial thermometers and industrial instruments is most complete, including self-contained and distant reading dial thermometers, recording thermometers, indicating and recording pressure gauges, engine registers, engine room clocks, etc. Literature will be sent upon request.

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Kessler Co.
Kimble Glass Co.
King Engineering
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Moeller Instrument Co.
Nurnberg Thermometer Co.
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Philadelphia Thermometer
Precision Therm. & Inst.
Ruttco Mfg. Co.
Scientific Instrument Co.
Seely Instrument Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Cos.
Trerice Co., H. O.
Weksler Thermometer

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Accuracy Scientific
Falchney Instrument Corp.
Fleischhauer & Son
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Manning, Maxwell & Moore
Moeller Instrument Co.
Nurnberg Thermometer Co.
Palmer Co.
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Rieker Instrument Co.
Schultheis Corp., E. W.
Scientific Instrument Co.
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Trerice Co., H. O.
Weksler Thermometer
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Brown Inst. Co.
Consol. Ashcroft Hancock
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Engelhard, Chas.
Foxboro Co.
Friez & Sons
Green, Henry J.
Mason-Neilan Regulator
Moeller Inst. Co.
Powers Regulator Co.
Practical Instrument Co.
Scientific Inst. Co.
Tagliabue Mfg. Co.
(Cont'd)

THERMOMETERS, Por ble (Cont'd)
Taylor Inst Cos.
Wagner & Son
Weksler Thermometer
Western Machinery C

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Bailey Meter Co.
Bristol Co.
Brown Inst. Co.
Cambridge Inst. Co.
De Jur Amsco Corp.
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Engelhard, Chas.
Foxboro Co.
General Elec. Co.
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Leeds & Northrup C
Manning, Maxwell & Mo
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Tagliabue Mfg. Co.
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Fee & Stemwedel
Foxboro Co.
Friez & Sons
Gotham Inst. Co.
Green, Henry J.
H-B Inst. Co., Inc.
H & H Thermostats
Manning, Maxwell & Mo
Mason-Neilan Regulat
Moeller Instrument C
Palmer Co.
Partlow Corp.
Ryan Recording Therm.
Standard Thermometer
Tagliabue Mfg. Co.
Taylor Inst. Co.
Weksler Thermometer

THERMOMETERS, R cording and/or Co trolling. Pressure-spring
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Bristol Co.
Brown Inst. Co.
Defender Automatic
Dickson Co.
Foxboro Co.
Gotham Inst. Co.
(Co

USTRIAL
ERMOMETERS

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TROL

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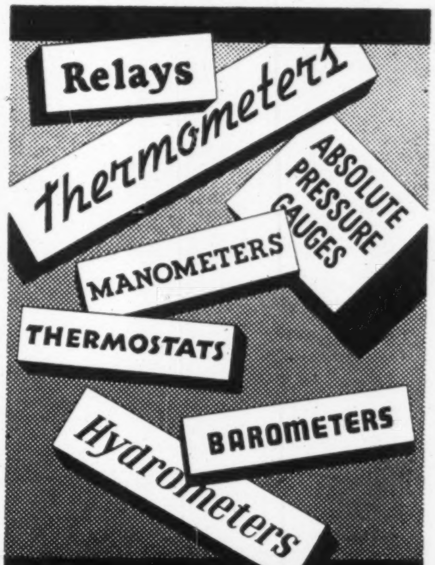
ENDER
ROMETERS



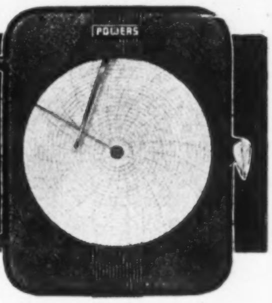
PRECISION
INSTRUMENTS FOR INDUSTRY

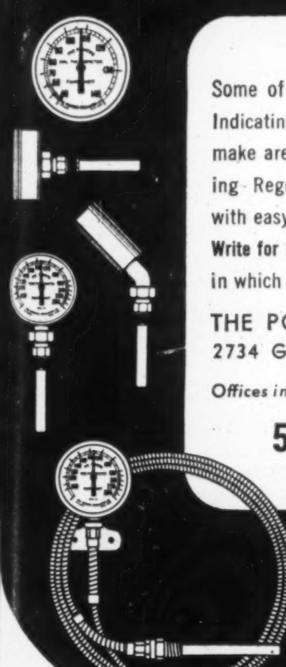
PRECISION THERMOMETER
AND INSTRUMENT COMPANY
PHILADELPHIA

ERIMENTAL AND DEVELOPMENTAL INSTRUMENT MAKING

POWERS

INDICATING
and
RECORDING THERMOMETERS



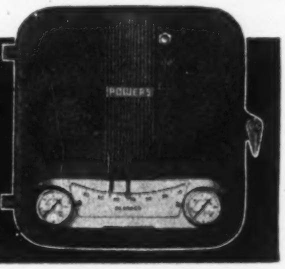


Some of the many different types of Dial Indicating and Recording Thermometers we make are shown here. We also make Recording Regulators and Regulators combined with easy to read Indicating Thermometers. **Write for Bulletins.** Specify type of instrument in which you are interested.

THE POWERS REGULATOR CO.
2734 Greenview Avenue, CHICAGO

Offices in 47 Cities—See your phone directory

50 Years of Temperature and ★ Humidity Control ★



MOELLER

PRECISION GRADE INSTRUMENTS

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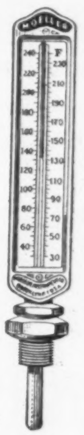

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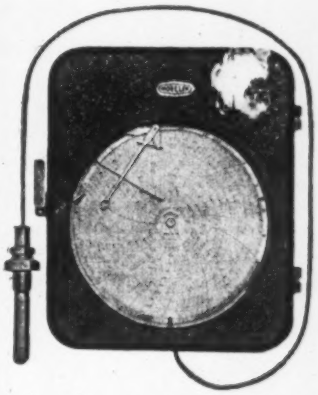
Made with "Moeller Glass Red Reading Column," making them easy to read under varying light conditions, at a considerable distance and over a wide range.

MOELLER DIAL THERMOMETERS. Made in various scale ranges up to 1000°F. or equivalent. Metal and Phenolite cases.



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Furnished in various ranges up to 1000°F. or equivalent. Round or square cases.

Also HYGROMETERS
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BAROMETERS HYDROMETERS
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ARMY E NAVY

Write for catalog.

MOELLER
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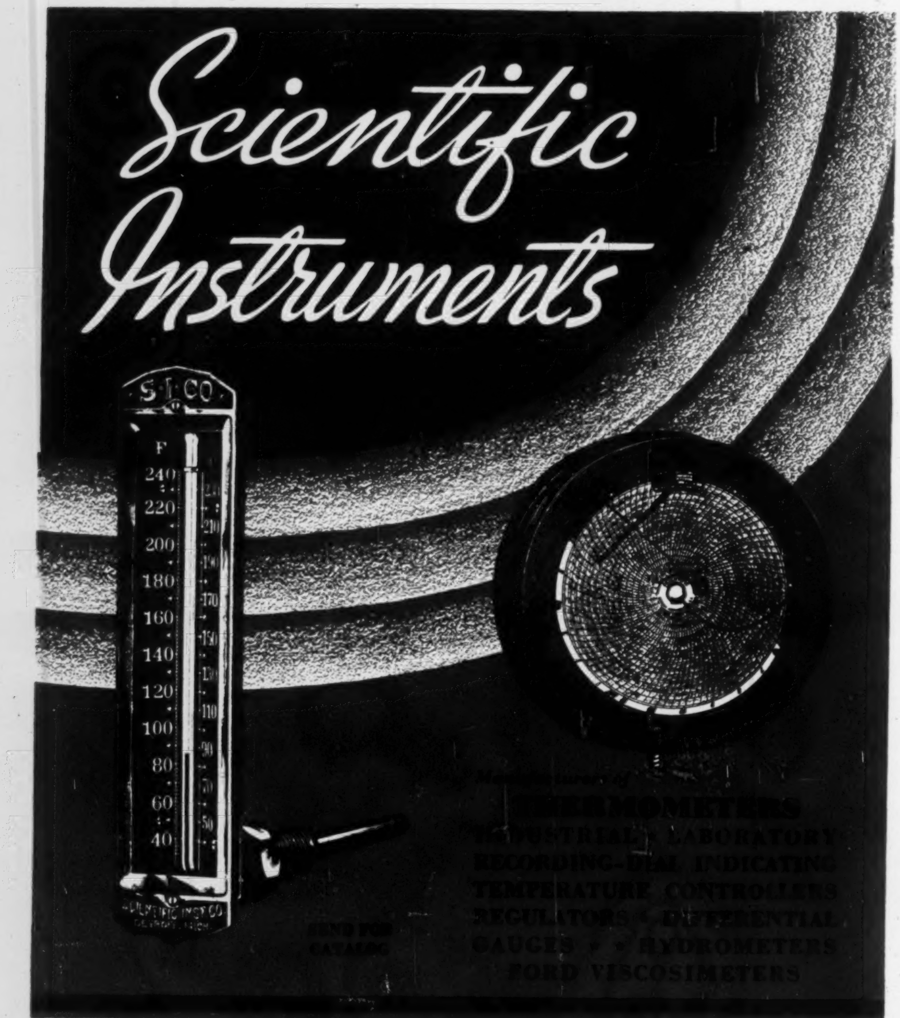

Manufacturers of
THERMOMETERS
INDUSTRIAL • LABORATORY
RECORDING-DIAL INDICATING
TEMPERATURE CONTROLLERS
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Maintenance and Servicing
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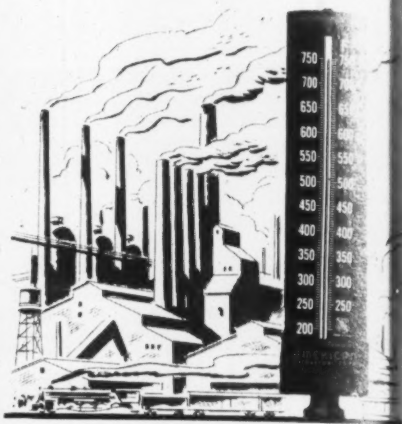
see page 126



750°F. is hot

An American thermometer with a high reading of 750° Fahrenheit may be subjected to that temperature continuously without injury to the instrument or impairment of its accuracy.

The red-reading mercury is easy to read. Wide-angled construction, glareless glass, dust-excluding construction and corrosion-proof finish are other features. Write to us for any information.

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AMERICAN
Industrial Instruments

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- Automatic Products Co.
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- Eastern Engg. Co.
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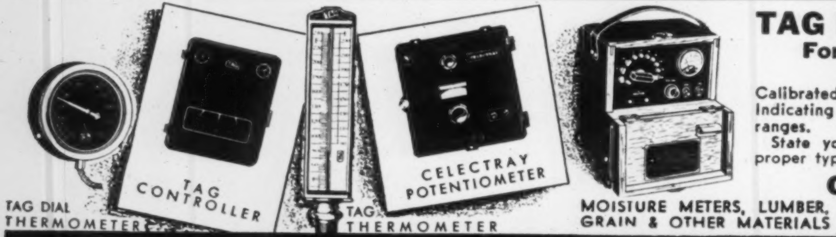


TAG INDICATING INSTRUMENTS
For Temperature, Pressure, pH, Level, Flow and Moisture

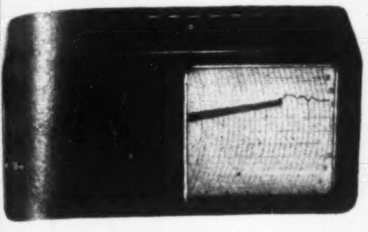
Calibrated against recognized standards of highest authority, TAG Indicating Instruments maintain a precise accuracy throughout their ranges.

State your indicating instrument needs and we will suggest the proper type for most economical service in your plant.

C. J. TAGLIABUE MFG. CO.
Park & Nostrand Avenues, Brooklyn 5, N. Y.

LOOK INSIDE the COVER (Part 1) *For a* **COMPLETE LIST** *of* **TAG INSTRUMENTS** TAG

PORTABLE
RECORDING
THERMOMETER



Ranges between
-100° and +200°F.

1. SENSITIVITY—1% of full range.
2. BI-METAL ELEMENT—Reliability.
3. COMPACTNESS—Only 3¾"x7¼"x2".
4. 24-HOUR CLOCK—A daily record.
5. CHART CARD—3" Scale length. 3"x3¼" card, ideal for writing test data, makes convenient permanent record for file.

● INK—A new development now available which withstands temperature extremes.

Inquiries invited

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General Elec. Co.
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Precision Scientific Co.
Precision Therm. & Inst.
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Ranco, Inc.
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Supreme Elec. Prods.
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Wilcolator Co.

THERMOSTATIC METALS (See Metals, Thermostatic)

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TIME, Controllers (See Controllers, Automatic, Time)

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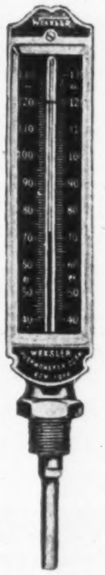
Production or Research Instruments

WEKSLER THERMOMETERS are scientific, precision instruments. Their rugged construction and lasting accuracy will merit your full confidence.



"V" Shaped Bronze Case Industrial

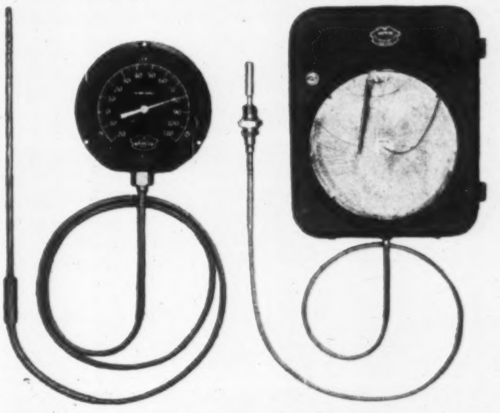
Red Reading or Yellow Back mercury tubes are furnished in all "V" shape industrial thermometers.

Indicating and Recording Thermometers are furnished mercury, vapor or gas actuated.

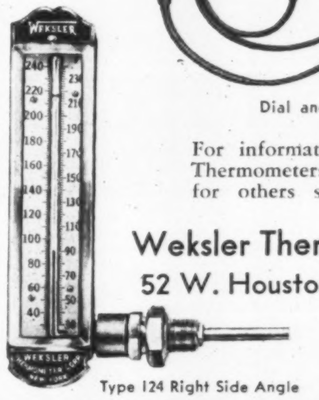
Dial Indicating Thermometers are available in 4½", 6" and 8½" phenol condensate cases, and Recording Thermometers in 10" chart size.

There is a Weksler precision thermometer for every industrial need!

Thermometers and Hydrometers



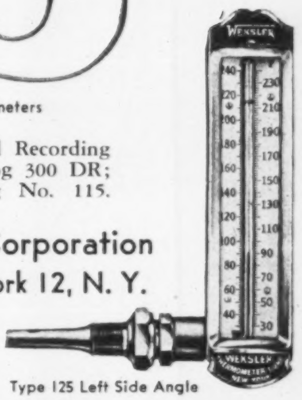
Dial and Recording Thermometers



Type 124 Right Side Angle

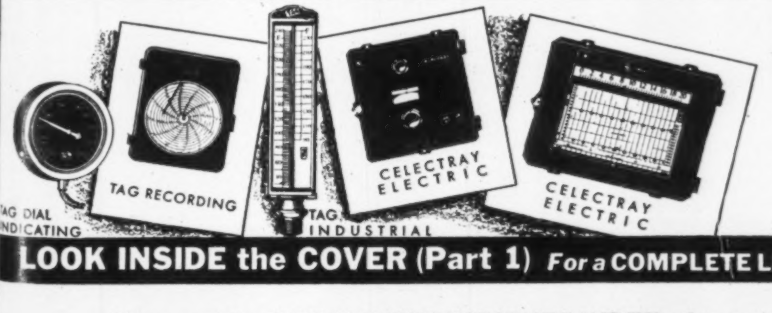
For information on Dial and Recording Thermometers send for Catalog 300 DR; for others send for Catalog No. 115.

Weksler Thermometer Corporation
52 W. Houston St., New York 12, N. Y.



Type 125 Left Side Angle

Maintenance and Servicing Electrical Instruments
see page 126



TAG THERMOMETERS

A complete line of Indicating and Recording Instruments from the precision mercury-in-glass thermometer to the modern CELECTRAY Pyrometer for laboratory and plant service. By virtue of simple and practical design, rugged construction and precise response to the slightest temperature change within their range, TAG Thermometers are the natural choice for economical supervision of temperatures in your plant.

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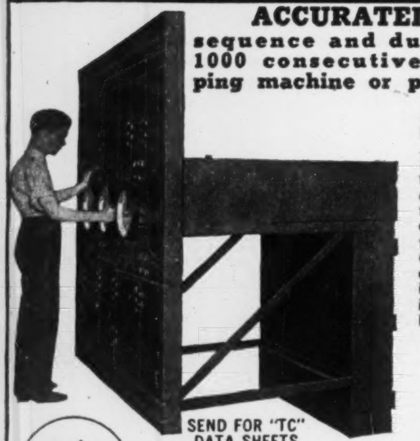


TIMERS

DESIGNED for INDUSTRIAL APPLICATIONS
● COMPLETE STANDARD LINE AVAILABLE
● SYSTEMS FOR SPECIAL REQUIREMENTS

ACCURATELY CONTROL sequence and duration of 1 to 1000 consecutive and overlapping machine or process functions

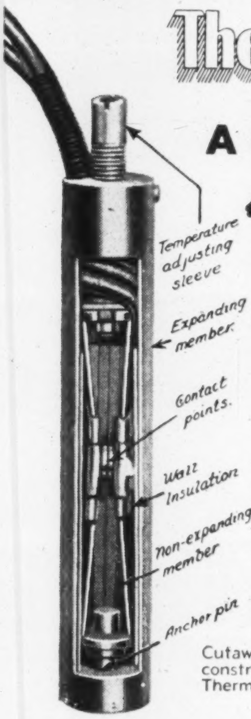
← SYNTHETIC RUBBER PROCESS TIME CONTROL . . . one of largest built! Synchronous motors drive twin shafts, each with 41 cams and mercury switches to control operations. Cam cycle may be adjusted in steps from 6 to 18 min. Color coded flow chart, indicator lights, common terminal board, enclosed cabinet, internal lighting and lock-handle doors are features.

Why YOU SHOULD INCLUDE ATC TIMERS IN YOUR MACHINE OR PROCESS DESIGN
Assure Uniform Product
Obtain Maximum Operation
Increase Output
Reduce Rejects
Eliminate Human Errors
Save Man-hours
Conserve Skilled Operators
Cut Production Cost

SEND FOR "TC" DATA SHEETS

atc Industrial Controls

AUTOMATIC TEMPERATURE
CONTROL COMPANY, INC.
34 E. LOGAN STREET, PHILA. 44, PA.



Thermoswitches

A Principle
worth Ponderin

The basic principle of the Fenwal The
moswitch results in a unit of laborator
accuracy with commercial stability. Th
construction is a brass tube in which
suspended thermally inert struts carry
ing silver contacts. Contraction an
expansion of brass tube causes separa
tion of contacts in a ratio of 20 to
Since the surface of the brass tube
the temperature detecting means extrem
sensitivity is possible and the hig
spring tension on struts gives freedo
from vibration effects.

●

Maximum rating — 10 Amps 115
Sensitivity — plus or minus 1/10°
Range — minus 100° F. to 600° F.

Cutaway at left shows basic construction of the Cartridge Thermoswitch. (A5000)

Fenwal INCORPORATE
6 PLEASANT ST., ASHLAND, MASSACHUSETTS

"TIME-IT"
ELECTRIC STOP WATCH

DRIVEN by a synchronous electric motor and having a direct reading indicating counter, instead of a hard-to-read dial, "Time-It" possesses the accuracy comparable to the finest stopwatches—plus the advantage of being able to withstand plenty of abuse. Two models available. "Second" model reads to 1/10 second. "Minute" model reads directly to 1/100 minute.

Write for Bulletin

PRECISION SCIENTIFIC COMPANY
1750 N. SPRINGFIELD, CHICAGO

Interval Timers

Process Timers

Signal Timers

Time Switches

Relays

Write

AUTOMATIC
ELECTRIC
MANUFACTURING CO.
MANKATO, MINNESOTA

TIME Indicators
Automatic Electric
Bristol Co.
Cramer Co., R. W.
Fuess, Inc.
Gaertner Scientific Corp.
Gotham Inst. Co.
Industrial Timer
Jaeger Watch Co.
National Time & Signal
Paragon Electric Co.
Precision Scientific Co.
Rawson Electrical Inst.
Standard Elec. Time
Stromberg Electric Co.
Tagliabue Mfg. Co.
Thompson Clock Co.

TIME, Recorders
Am. Automatic Electric
Bristol Co.
Cramer & Co., Inc.
Esterline-Angus Co.
Friez & Sons
Fuess, Inc.
Gaertner Scientific Corp.
Gotham Inst. Co.
Jaeger Watch Co.
Paragon Electric Co.
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Seely Instrument Co.
Service Recorder Co.
Simplex Time Recorder
Stromberg Electric Co.
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TIME INTERVAL APPARATUS
Am. Gas Accumulator
Barber-Coleman
Betts & Betts
Builders-Providence
Coleman Elec. Co.
Cramer & Co., Inc.
Dayton Acme Co.
Edison, Instrument Div.
General Electric X-Ray
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Guardian Elec. Mfg. Co.
Lektra Labs.
Marston Co.
National Time & Signal
(Cont'd)

TIME INTERVAL APPA RATUS (Cont'd)
Paragon Electric Co.
Perfex Corp.
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Stromberg Electric Co.
Thompson Clock Co.
United Cellophane Corp.
Walser Automatic Tim
Warren Telechron Co.
Westinghouse Elec. & Mf
Zenith Electric Co.

TIME METERS (S meters, time)

TIME OPERATION, R corders
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Automatic Time Stamp
Bristol Co.
Brown Inst. Co.
Calculagraph Co.
Cincinnati Time Rec.
Cramer & Co., Inc.
Elec. Tachometer Corp.
Elematic Sales Corp.
Esterline-Angus Co.
Gaertner Scientific Cor
General Elec. Co.
Gorrell & Gorrell
Gotham Inst. Co.
Intern'l Business Mac
Jaeger Watch Co.
Manning, Maxwell & Moo
Marston Co.
National Time & Signal
Paragon Electric Co.
Practical Instrument C
Production Inst. Co.
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TIME STAMPS
Automatic Time Stamp
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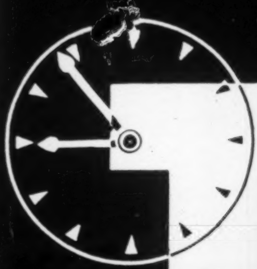
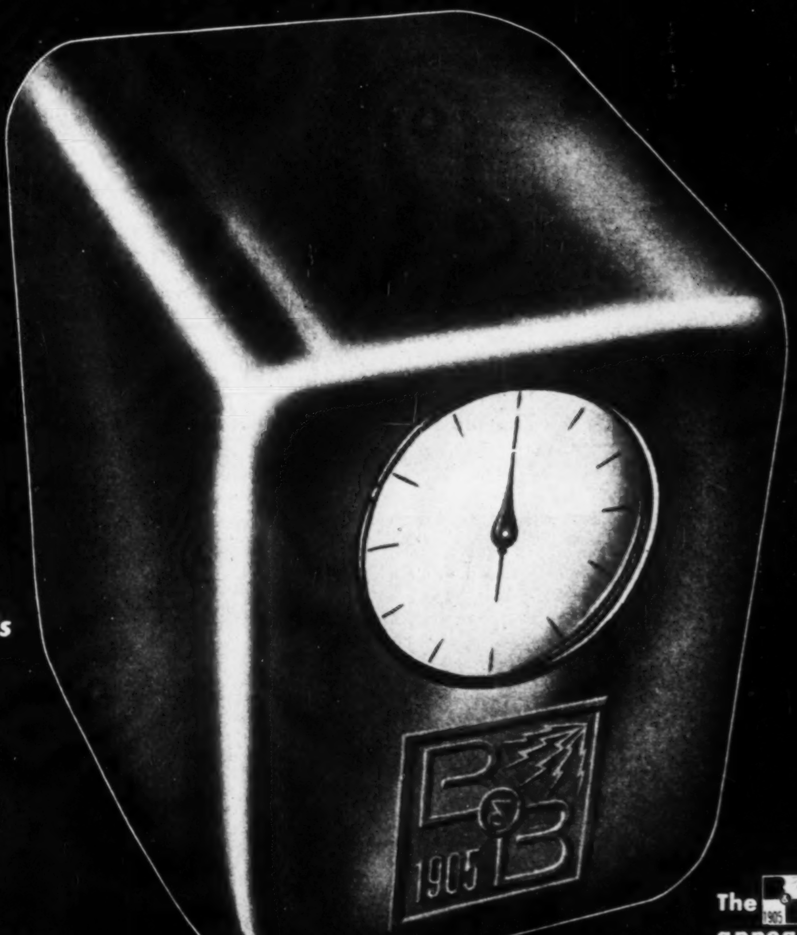
Stromberg Electric Co.



TIME

is of the Essence ...



- ***Timers***
- ***Time Delay Switches and Relays***
- ***Program Controls***
- ***Process Timers***
- ***Impulse Timers (Therapeutic)***
- ***Signal Switches***
- ***Traffic Controls***
- ***Flashers***
- ***Electric and Neon Cypher-Clock Controls***

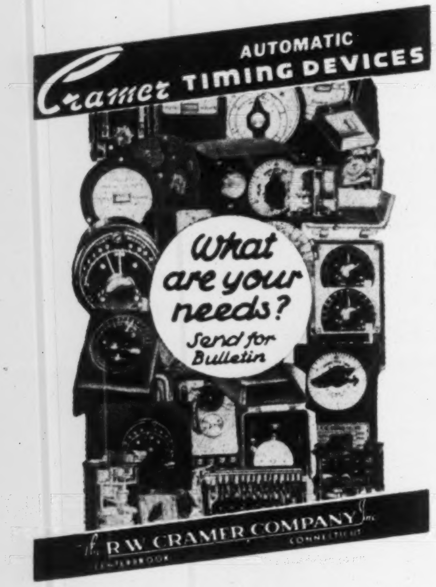
The B & B 1905 trade mark appears on control instruments in every industry where it is important to control time—TO SAVE TIME.

BETTS & BETTS

CORPORATION

551 WEST 52nd STREET, NEW YORK, N. Y.

CONTROLLING TIME FOR ALMOST HALF A CENTURY



TIME STUDY APPARATUS
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Standard Electric Time Co.
Warren Telechron

TIME SWITCHES (See Switches, Time)

TIMERS, AUTOMATIC, Automatic Reset
Abrams Instrument
Am. Gas Accumulator
Automatic Elec. Co.
Automatic Elec. Mfg.
Automatic Temp. Control
Betts & Betts
Bristol Co.
Cramer & Co., Inc.
Struthers-Dunn
Eagle Signal Corp.
Edison, Instrument Div.
Guardian Elec. Mfg. Co.
Industrial Timer
Lektra Labs.
Mason-Neilan Regulator
National Time & Signal
Paragon Electric Co.
Photovolt Corp.
Production Inst. Co.
Rowe Research Lab.
Stromberg Electric Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Warren Telechron
Zenith Electric Co.

TIMERS, AUTOMATIC, Cycle
Abrams Instrument
Am. Gas Accumulator
Autocall Co.
Automatic Elec. Co.
Automatic Temp. Control
Barber Coleman
Betts & Betts
Bristol Co.
Brown Inst. Co.
Controls, Inc.
Cramer & Co., Inc.
Dayton Acme Co.
Eagle Signal Corp.
Elec. Switch Corp.
Foxboro Co.
Hanlon-Waters, Inc.
Industrial Timer
(Cont'd)

TIMERS, AUTOMATIC, Cycle (Cont'd)
Lektra Labs.
Manning, Maxwell & Moore
Minneapolis-Honeywell
National Time & Signal
Paragon Electric Co.
Penn Electric Switch
Photovolt Corp.
Richardson-Allen
Sangamo Electric Co.
Seely Instrument Co.
Standard Elec. Time
Stromberg Electric Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Thomas Clock Co.
Thompson Clock Co.
Walser Automatic Timer
Warren Telechron
West. Electro-Mechanical
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.
Wheelco Inst. Co.
Zenith Electric Co.

TIMERS, AUTOMATIC, Interval
Abrams Instrument
Am. Gas Accumulator
Anderson, A & J. M.
Automatic Elec. Co.
Automatic Elec. Mfg.
Automatic Temp. Control
Bacon Electric Timer
Barber-Colman
Betts & Betts
Bristol Co.
Controls, Inc.
Cramer & Co., Inc.
Dayton Acme Co.
Eagle Signal Corp.
Echo Electrical
Edison, Instrument Div.
Elec. Switch Corp.
Fink-Roselieve Co.
General Electric X-Ray
Glogau & Co.
Guardian Elec. Mfg.
Hagedorn Engineering
Hankscraft Co.
Heiland Research
Industrial Engr. Corp.
Industrial Timer Corp.
Leeds & Northrup
Lektra Labs.
Luers, J. Milton
Minneapolis-Honeywell
Metron Instrument
National Time & Signal
Paragon Electric Co.
Perfex Corp.
(Cont'd)

TIMERS, AUTOMATIC, Interval (Cont'd)
Photovolt Corp.
Production Inst. Co.
Richardson-Allen
Rowe Research Lab.
Seeley Instrument
Standard Elec. Time
Stromberg Electric Co.
Struthers-Dunn
Tagliabue Mfg. Co.
Thomas Clock Co.
Thompson Clock Co.
United Cinephone
Walser Automatic Timer
Warren Telechron
Zenith Electric Co.

TIMERS, AUTOMATIC, Process
Am. Gas Accumulater
Autocall Co.
Automatic Elec. Co.
Automatic Elec. Mfg.
Automatic Temp. Control
Barber Coleman
Betts & Betts
Bristol Co.
Controls, Inc.
Cramer & Co., Inc.
Dayton Acme Co.
Denver Fire Clay
Eagle Signal Corp.
Electric Controller
Elec. Switch Corp.
Foxboro Co.
Gaertner Scientific Corp.
Industrial Engr. Corp.
Jardur Import
Lektra Labs.
Magnetic Gauge Co.
Manning, Maxwell & Moore
National Time & Signal
Paragon Electric Co.
Powers Regulator Co.
Richardson-Allen
Rowe Research Lab.
Seely Instrument Co.
Stromberg Electric Co.
Struthers-Dunn
Tagliabue Mfg. Co.
Taylor Inst. Cos.
United Cinephone Corp.
Warren Telechron
West. Electro-Mechanical
Weston Elec. Inst. Corp.
Woermann-Schuchhardt
Zenith Electric Co.

TIMERS, AUTOMATIC, Spot Weld
Allen-Bradley Co.
Am. Gas Accumulater
Cramer & Co., Inc.
Cutler-Hammer, Inc.
Electric Controller
General Elec. Co.
Industrial Timer
National Time & Signal
Photovolt Corp.
United Cinephone Corp.

TITRATION APPARATUS, Electrometric
Burrell Technical Supply
Buhl Optical
Cambridge Instrument Co.
Central Scientific Co.
Coleman Electric Co.
Fisher Scientific Co.
Leeds & Northrup Co.
National Technical Labs.
Rubicon Co.
Sargent & Co., E. H.
Thomas Co., Arthur H.
Welch Mfg. Co.

TOOLS, Precision
Ideal Lab. Tool
Marshall Co.

TOOLMAKER'S FLATS
Bausch & Lomb Opt.
Buhl Optical
Fecker, J. W.
Pratt & Whitney
Ruska & Co.
Van Keuren Co.
Zeiss, Inc., Carl

TOPOGRAPHIC INSTR MENTS (See Surve ing Instruments)

TORQUE GAGES (S Gages, Torque)

TORQUE MEASURING EQUIPMENT
Apco Mossberg Co.
Snap-on Tools Corp.
Sturtevant Co.
Waugh Laboratories

TORSIOGRAPH
Baldwin-Southwark Co
Commercial Research
Consolidated Engg.

TORSION METERS
Boulin Inst. Corp.
Chatillon & Sons
Cummings Mach. Wor
Kurman Electric Co.
McNab of Bridgeport
Riehle Div.
Saxl Inst. Co.
Toledo Scale Co.

TOTALIZERS, Demand
American Meter Co.
General Elec. Co.
Therm-Electric Meters C
United Cinephone Corp
Westinghouse Elec. & Mf

TOTALIZERS, Electric En ergy
Autocall Co.
Bristol Co.
Esterline-Angus Co.
General Elec. Co.
Therm-Electric Meters Co
Westinghouse Elec. & Mf

TOTALIZERS, Fluid Flo
American Meter Co.
Bailey Meter Co.
Brown Inst. Co.
Fischer & Porter
Foxboro Co.
Hersey Co.
Leupold & Stevens
Mason-Neilan Regulator
Republic Flow Meters
Tagliabue Mfg. Co.
Taylor Inst. Cos.

TOTALIZERS, Gas Flow
American Meter Co.
Fischer & Porter

TOTALIZERS, Running Time
Cramer & Co., Inc.
Elec. Tachometer Corp.
Photoswitch, Inc.
Production Instrument
United Cinephone Corp.
Westinghouse Elec. & Mfg.

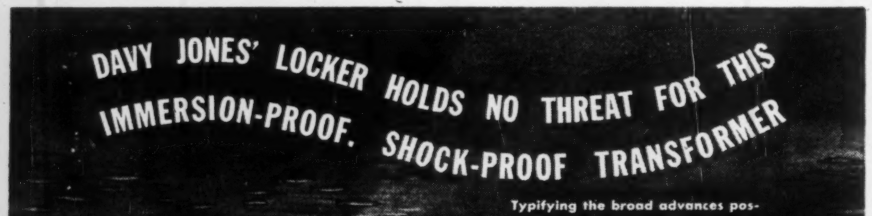
TRAFFIC SIGNALING DEVICES (See Signaling Devices, Traffic)

TRAMMELS, Steel Beam
Union Tool Co.

TRANSFORMERS, Adjustable
General Radio Co.
Merit Coil & Transformer
Superior Electric Co.

TRANSFORMERS, Constant Voltage
Sola Electric Co.

TRANSFORMERS, Experimenter's Variable Voltage
Dongan Electric Mfg.
Merit Coil & Transformer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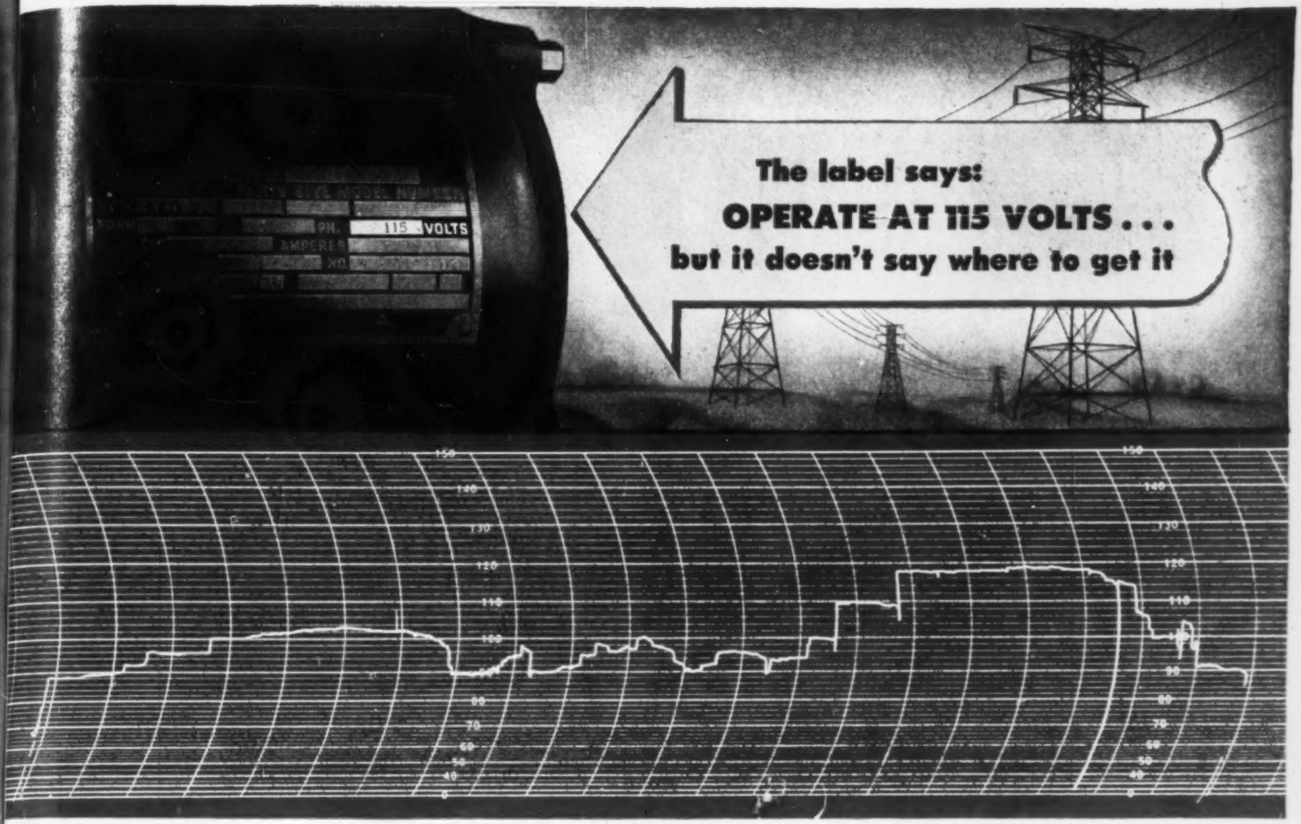
Maintenance of Electrical Instruments

See page 126



RATED VOLTAGE is always available to equipment protected with built-in CONSTANT VOLTAGE

"Operate at 115 volts" on the label of electrically operated precision equipment is not simply informative –*it's a warning!*

A *warning* that the device is too sensitive to tolerate the voltage fluctuations that may be met on America's power lines, and still perform with efficiency. A *warning* that sensitive tubes and other delicate mechanisms may be irreparably damaged by line surges and that costly replacements, with consequent loss of time and efficiency, lie ahead.

The design engineer who assumes that the precisely controlled voltages of the research laboratory will be duplicated in the field is heading his product toward trouble. Nominal line voltage ratings can no longer be used as single, stable reference points for design considerations. Commercial power lines are too heavily loaded and unpredictable.

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Sola Constant Voltage Transformers have no moving parts to get out of order. There are no manual adjustments to be made. They perform instantly and automatically, maintaining output constant to within ± 1% of the rated voltage, regardless of line fluctuations as great as 30%.

Constant Voltage Transformers

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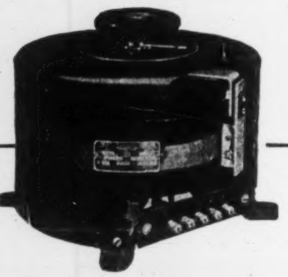

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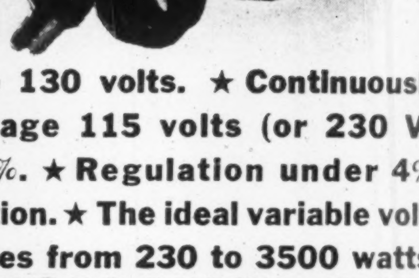
Maintenance of Electrical Instruments
See Page 126



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Amplifier Co.
Annis Co.
Associated Research
Chicago Transformer
Cole Instrument
Columbia Elec. Mfg.
Control Corp.
Davis & Co.
Dongan Electric Mfg.
Elec. Facilities, Inc.
Esterline-Angus Co.
Friez & Sons
General Elec. Co.
Hickok Elec. Inst. Co.
Industrial Engr. Corp.
Lipman Engg. Co.
Merit Coil & Trans.
Miller Co., Bertrand F.
New York Transformer
Nothelfer Winding Labs.
Roller-Smith Co.
Sangamo Electric Co.
Thordarson Elec. Co.
Utah Radio Produs.
United Transformer Corp.
West, Electro-Mechanical
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

TRANSFORMERS, Insulation Testing
Campbell Electric
Dongan Electric Mfg.
Merit Coil & Transformer
Nothelfer Winding Labs.

TRANSFORMERS, Laboratory
Allied Radio Corp.
American Transformer
Amplifier Co.
Burrell Tech. Supply
Central Scientific Co.
Clough-Brengle Co.
Daven Co.
Davis & Co.
Dongan Electric Mfg.
Eastern Specialty Co.
Elec. Facilities, Inc.
General Elec. Co.
General Radio Co.
Gorrell & Gorrell
Halldorson Co.
Merit Coil & Trans.
Miller Co., Bertrand F.
New York Transformer
Nothelfer Winding Labs.
Raytheon Mfg. Co.
Sola Electric Co.
Standard Elec. Prods.
(Cont'd)

TRANSFORMERS, Laboratory (Cont'd)
Superior Electric Co.
Thordarson Elec. Co.
United Transformer Corp.
Westinghouse Elec. & Mfg.
Weston Elec. Inst. Corp.

TRANSFORMERS, Phasing
Allied Radio Corp.
Davis & Co.
Dongan Electric Mfg.
Eastern Specialty Co.
Merit Coil & Trans.
New York Transformer
States Co.
Thordarson Mfg. Co.
United Transformer Corp.
Westinghouse Elec. & Mfg.

TRANSFORMERS, Power
Allied Radio Corp.
Amplifier Co.
Chicago Transformer
Ferranti Electric
Hollywood Transformer
Merit Coil & Trans.
New York Transformer

TRANSFORMERS, Split Core
Allied Radio Corp.
Annis Co.
Cole Instrument
Davis & Co.
Elec. Facilities, Inc.
General Elec. Co.
H-D Elec. Co.
Industrial Eng. Corp.
Merit Coil & Transformer
Roller-Smith Co.
Rubicon Co.
Sangamo Electric Co.
Thordarson Elec. Co.
United Transformer Corp.
Western Electro-Mech.
Westinghouse Elec. & Mfg.

TRANSFORMERS, Variable Voltage Testing
American Transformer
Dongan Electric Mfg.
Merit Coil & Trans.
Superior Electric Co.

TRANSFORMERS, Voltage Regulating
Allied Radio Corp.
Davis & Co., Inc., Dean
Echo Electrical
Merit Coil & Transformer
United Transformer Corp.

TRANSITS, Engineer's (See Surveying Instruments)

TRANSITS, Pocket
Ainsworth & Sons
Keuffel & Esser Co.
Mico Instrument Co.
Speidel & Co.
Warren-Knight Co.
White Co., Inc.

TRUCK MILEAGE RECORDERS (See Meters, Mileage)

TRUCK-TIME RECORDERS
Cramer & Co., Inc.
Durant Mfg. Co.
Knopf, Paul
Ohmer Register Co.
Service Recorder Co.

TRUCK, TIME & MILEAGE RECORDERS
Cramer & Co., Inc.
Ohmer Register Co.
Sangamo Electric Co.

TUBES (See also Gas & Vapor Discharge Tubes)

TUBES, Cathode Ray (See Cathode Ray Tubes)

TUBES, Nessler (See Nessler Tubes)

TUBES, Oil Centrifuge (See Oil Centrifuge Tubes)

TUBES, Photoelectric
Continental Electric Co.
General Electric Co.
General Scientific Corp.
Photobell Corp.
RCA Manufacturing
United Cinephone Corp.
Vacutron, Inc.

TUBES, Pitot (See Flowmeters, Pitot Tube)

TUBES, Polariscope
Akatos, Inc.
American Inst. Co.
Bausch & Lomb Optical
Central Scientific Co.
Elmer & Amend
Fecker, J. W.
Gaertner Scientific Corp.
Hellige Inc
Jarrell-Ash Co.
Precision Scientific Co.
Sargent & Co.
Woermann-Schuchhardt

TUBES, Precision Bore (See Precision Bore Glass Tubing)

TUBES, Pyrometer
Bristol Co.
Brown Inst. Co.
Campbell Co., J. A.
Eitzen Co.
Elematic Sales Corp.
Fish-Schurman Corp.
Hoskins Mfg. Co.
Illinois Testing Labs.
Leeds & Northrup Co.
Richards, Arklay S.
Tagliabue Mfg. Co.
Taylor Instrument Cos.
Thermo-Electric Co.
Trinity Equipment
Wheelco Instruments

TUBES, Spectrum (See Spectrum Tubes)

TUBES, Ultra-Violet Light (See Ultra-Violet Light Sources)

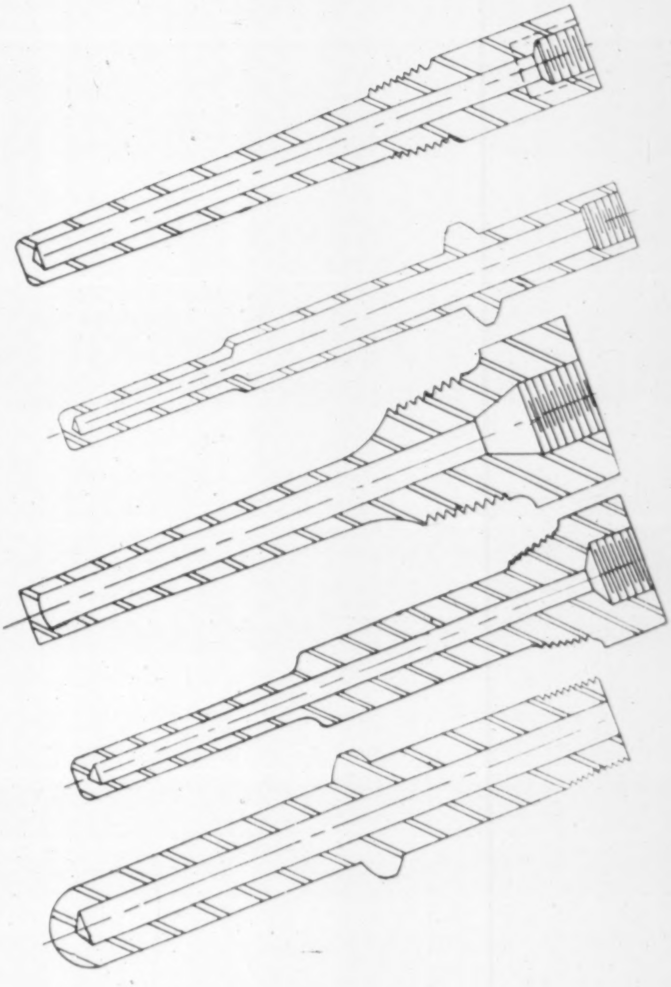
TUBES, Vacuum
Arcturus Radio Tube Co.
Central Scientific Co.
Federal Telegraph
Fredericks, George
General Elec. Co.
General Scientific Corp.
General Television Corp.
Raytheon Mfg. Co.
RCA Manufacturing Co.
Vacutron, Inc.
Wheelco Inst. Co.

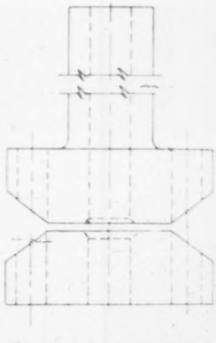
TUBES, Venturi (See Flowmeters, Venturi)

TUBES, X-Ray
American Inst. Co.
Baird Associates
Corning Glass Works
General Electric X-Ray
Jarrell-Ash Co.
Kelley-Koett Mfg.
Westinghouse X-Ray Co.
Wyland, George

TUNING FORKS, Electrically Driven (See Forks, Tuning)

THERMOWELL
HEADQUARTERS





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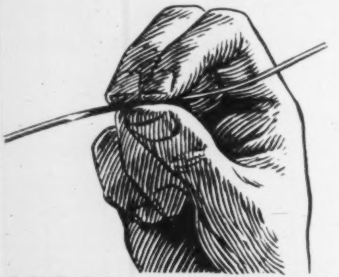

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- **Eimer & Amend**
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- Fisher Scientific Co.
- Hellige, Inc.
- Klett Mfg. Co.
- Kimble Glass Co.
- Parr Instrument Co.
- Pfaltz & Bauer, Inc.
- Photoswitch, Inc.
- **Photovolt Corp.**
- Precision Scientific Co.
- **Rawson Electrical Inst.**
- **Rubicon Co.**
- Sensitive Research Inst.
- Zeiss, Inc., Carl

TURN & BANK INDICATORS
- **Kollsman Inst. Co.**
- **Pioneer Instrument**

TURN INDICATOR TESTERS (See Testers, Turn Indicator)

TWEEZERS
- **Marshall Co.**

TWIST COUNTERS (See Counters, Twist)

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- Gen. Elec. Lamp Dept.
- Hanovia Chem. & Mfg. Co.
- **Photovolt Corp.**

ULTRA-VIOLET LIGHT SOURCES (See Light Sources)

U-TUBE MANOMETERS (See Manometers)

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- Baird Associates
- **Continental Elec. Co.**
- Fuess, Inc.
- **General Elec. Co.**
- **Winslow Co.**
- **Xervac Inst. Co.**

VACUUM GAGES, Ionization
- Distillation Products
- **Fredericks, George**
- General Elec. Co.
- General Television Corp.

VACUUM GAGES, Liquid-column
- **American Meter Co.**
- Bacharach Industrial Inst.
- Defender Automatic Reg.
- Dubrovin, John
- Gas Appliance Specialties
- Ideal Lab. Tool
- Lantz-Phelps Corp.
- **Meriam Co.**
- **Moeller Inst. Co.**
- Pioneer Instrument
- Precision Term. & Inst.
- Scientific Glass Apparatus
- **Tagliabue Mfg. Co.**
- **Taylor Inst. Cos.**
- Uehling Instrument Co.

VACUUM GAGES, McLeod
- Ace Glass, Inc.
- Central Scientific Co.
- **Eimer & Amend**
- **General Elec. Co.**
- General Physical Lab.
- Macalaster Bicknell Co.
- Scientific Glass Apparatus
- **Stokes Machine Co.**
- Welch Mfg. Co.

VACUUM GAGES, Pirani Type
- Distillation Products
- **Winslow Co.**

VACUUM, Indicators
- **American Meter Co.**
- Ashton Valve Co.
- **Bailey Meter Co.**
- Baird Associates
- **Bristol Co.**
- **Brown Inst. Co.**
- Central Scientific Co.
- Clapp Instrument
- Distillation Products
- **Eimer & Amend**
- **Foxboro Co.**
- **Fredericks, George**
- General Elec. Co.
- **Kollsman Inst. Co.**
- Manning, Maxwell & Moore
- **Marsh Corp.**
- **Mason-Neilan Regulator**
- **Moeller Instrument Co.**
- Pioneer Instrument
- Potter Co.
- **Precision Therm.**
- **Rawson Electrical Inst.**
- Republic Flow Meters
- Rochester Mfg. Co.
- Scientific Glass Apparatus
- Star Brass Mfg. Co.
- **Tagliabue Mfg. Co.**
- **Taylor Inst. Cos.**
- Uehling Instrument Co.

VACUUM, HIGH (below 1 mu) Controllers, Indicators & Recorders
- Baird Associates
- **Continental Elec. Co.**
- **Eimer & Amend**
- Electronic Prod. Co.
- **General Elec. Co.**
- General Physical Lab.
- **National Research**
- **Welch Mfg. Co.**

VACUUM RECORDERS
- **American Meter Co.**
- Ashton Valve Co.
- **Bailey Meter Co.**
- **Bristol Co.**
- **Brown Inst. Co.**
- Dickson Co
- Distillation Products
- Esterline-Angus Co.
- **Foxboro Co.**
- **Fredericks, George**
- Manning, Maxwell & Moore
- **Marsh Corp.**
- **Mason-Neilan Regulator**
- Republic Flow Meters
- Schwien Engineering
- Scientific Instrument Co.
- **Tagliabue Mfg. Co.**
- **Taylor Inst. Cos.**
- Uehling Instrument Co.

VACUUM SPECTROGRAPHS (See Spectrographs, Vacuum)

VACUUM TUBES (See Tubes, Vacuum)

VACUUM TUBE BRIDGES (See Bridges, Vacuum Tube)

VACUUM TUBE RELAYS (See Relays, Vacuum Tube)

VACUUM TUBE VOLTMETERS (See Voltmeters, Vacuum Tube)

VALVE BOX FINDER (See Finder, Valve Box)

VALVE-OPERATING DEVICES, Electric Motor
- Baldwin-Southwark Corp.
- Barber-Coleman Co.
- Beck Co.
- Bristol Co.
- **Brown Inst. Co.**
- **Cramer & Co., Inc.**
- Cutler-Hammer, Inc.
- Dickson Co.
- **Foxboro Co.**
- **General Controls Co.**
- **Hays Corp.**
- Illinois Eng. Co.
- Jenkins Bros.
- McAlear Mfg. Co.
- Ruggles-Klingemann
- **Tagliabue Mfg. Co.**

VALVE OPERATING DEVICES, Electric Solenoid (See Valves, Solenoid)

VALVE OPERATING DEVICES, Hydraulic (See Valves, Hydraulically Operated)

VALVE-OPERATING DEVICES, Pneumatic (See Valves, Diaphragm)

VALVE POSITION INDICATORS
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- Autocall Co.
- Automatic Temp. Control

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VALVE POSITION INDICATORS (Cont'd)
- **Bailey Meter Co.**
- **Barber Coleman**
- Beck Co.
- **Bendix Marine Products**
- **Bristol Co.**
- **Builders-Providence**
- Elec. Indicator Co.
- **Elec. Tachometer Corp.**
- **Foxboro Co.**
- General Regulator Corp.
- Hanlon-Waters, Inc.
- Leupold & Stevens
- Manning, Maxwell & Moore
- **Merco Nordstrom Valve**
- Moore Products
- Northern Equip. Co.
- **Tagliabue Mfg. Co.**
- **Taylor Inst. Cos.**
- Tefft-Jackson, Inc.
- Westinghouse Elec. & Mfg.

VALVES, Automatic Shut-off
- Adel Precision
- Automatic Switch Co.
- Automatic Valve Control
- **Barber-Colman**
- Bastian-Blessing
- Belfield Co.
- **Brown Inst Co.**
- Davis Reg. Co.
- Edison, Instrument Div.
- **Fisher Governor Co.**
- Foster Engg. Co.
- **Frick Co.**
- **Friez & Sons**
- **General Controls Co.**
- General Sales & Prod.
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- Kiely & Mueller
- McAlear Mfg. Co.
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- **Merco Nordstrom Valve**
- Minneapolis-Honeywell
- Partlow Corp.
- Ruggles-Klingemann
- Payne Furnace & Supply
- Schade Valve Mfg. Co.
- **Tagliabue Mfg. Co.**
- **Wheelco Instruments**
- Wilgus Mfg. Co.

VALVES, Automatic Solenoid (See Valves, Solenoid)

VALVES, Balanced
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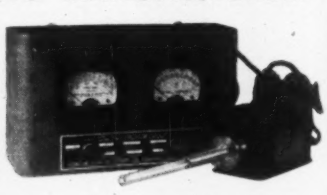
- Atlas Valve Co.
- **Bailey Meter Co.**
- Baldwin Southwark
- **Barber Coleman**
- Belfield Co.
- Boylston Co.
- **Bristol Co.**
- Cash Co.
- **Cochrane Corp.**
- Connelly Iron Sponge
- Davis Reg. Co.
- Defender Automatic Reg.
- D'Este Co.
- **Fisher Governor Co.**
- Ford Reg. Valve Co.
- Foster Engg. Co.
- **General Controls Co.**
- Hanlon-Waters, Inc.
- Illinois Eng. Co.
- Jenkins Bros.
- Kiely & Mueller
- Klipfel Mfg. Co.
- **Mason-Neilan Regulator**
- McAlear Mfg. Co.
- Minneapolis-Honeywell
- Natural Gas Equipment
- Northern Equip. Co.
- **Powers Regulator Co.**
- Republic Flow Meters
- Reynolds Gas Regulator
- Ruggles-Klingemann
- **Schade Valve Mfg. Co.**
- Seely Instrument Co.
- Spence Engineering Co.
- **Tagliabue Mfg. Co.**
- **Watts Regulator Co.**
- **Wilgus Manufacturing**



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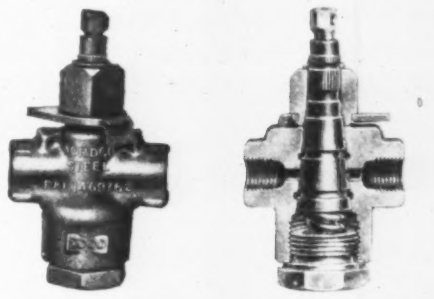

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Belfield Co.
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Bristol Co.
Brown Inst. Co
Cash Co.
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Davis Reg. Co.
Defender Automatic Reg
D'Este Co.
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Foster Engg. Co.
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Kiely & Mueller
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Minneapolis-Honeywell
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Refrigerating Spec. Co.
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Reynolds Gas Regulator
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(Cont'd)
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Seely Instrument Co.
Spence Engineering Co.
Spencer Thermostat Co.
Tagliabue Mfg. Co.
Taylor Inst. Cos.
Vaughn-G E. Witt
White-Rodgers Electric
Wilgus Manufacturing

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Automatic Switch Co.
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Cutler-Hammer, Inc.
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Bristol Co.
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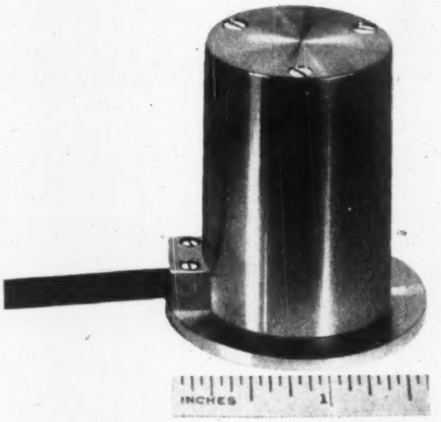

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Merco Nordstrom Valve

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Bristol Co.
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D'Este Co.
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Foster Engg. Co.
Foxboro Co.
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Watts Regulator Co.
Wilgus Manufacturing

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Cash Co.
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Fisher Governor Co.
Hanlon-Waters, Inc.
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Bastian-Blessing Co.
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Automatic Switch Co.
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Bristol Co.
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Cash Co.
Davis Reg. Co.
D'Este Co.
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Fisher Governor
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Spencer Thermostat Co.
Tagliabue Mfg. Co.
Viking Instrument Co.
Wheelco Instruments
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Automatic Switch Co.
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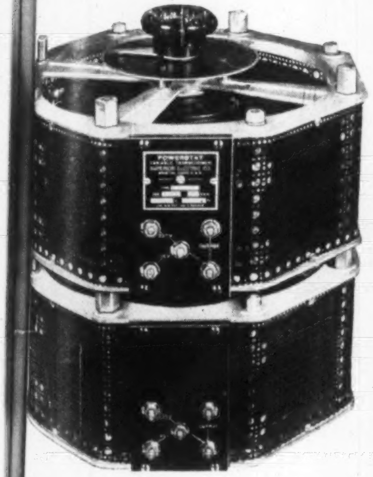

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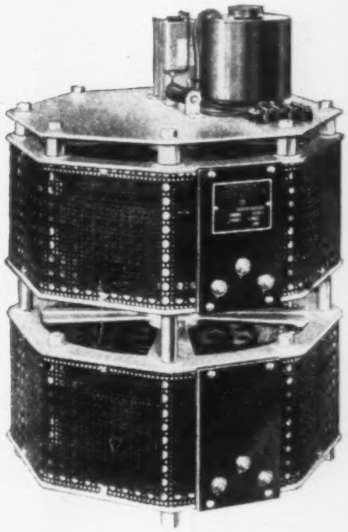

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Geophysical Instrument Co.
Hickok Electrical Inst.
Reliance Instrument Co.
Roller-Smith Co.
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Weston Electrical Inst.

VOLTMETERS, Electrostatic
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Ferranti Electric, Inc.
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VOLTMETERS, Indicating
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Ballantine Labs.
Boes Co., W. W.
Burton-Rogers Co.
Clough-Brengle Co.
Cole Instrument
Columbia Elec. Mfg.
Dayton Acme Co.
De Jur-Amsco Corp.
Electro-Tec Div.
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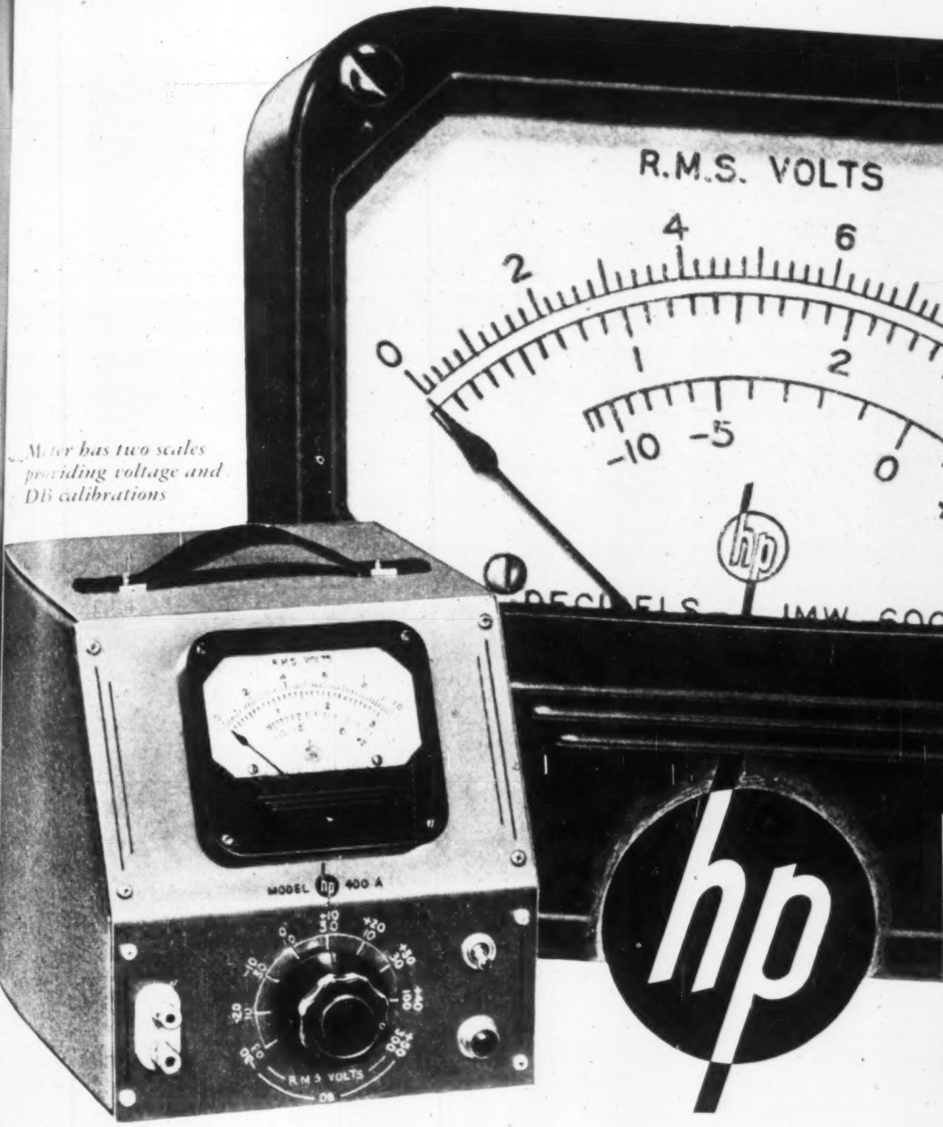

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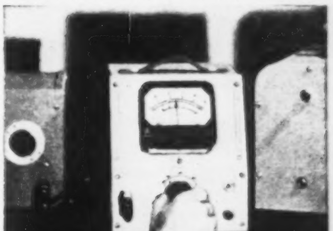

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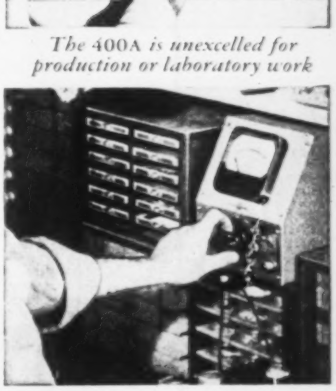

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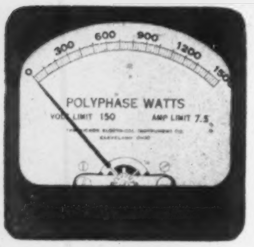

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ecision balances & weights, including analytical,
ay, magnetically damped, diamond, specific grav-
, dairy, druggists, textile.

r, Joseph, 630 W. 168th St., New York, N. Y.

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ld Co., H., Broad & Hamilton Sts., Philadel-
a, Pa.
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& howell Co., 1801-15 Larchmont Ave., Chicago,
tion picture equipment including cameras, pro-
tors & accessories

x Aviation Corp., Marine Division, 754 Lexing-
Ave., Brooklyn, N. Y.
rine Instruments of all types, annunciators,
tosyn motor ship, telegraphs, marine fittings, ma-
e telephone equipment, general industrial safety
signaling equipment

od Linze Co., 1832 Washington Ave., St. Louis,
tifier power units

, J. & H., 145 Hudson St., New York, N. Y.
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r & Sons, Inc., C. L., 37 Williams St., Rox-
y, Boston, Mass.
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., Chicago 14, Ill.

s and Betts, 551 West 52nd St., New York, N. Y.
ltiple circuit timers, controls, time delay relays
motor driven & thermostatic interrupters

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sulation testers, ground testers & ohmmeters,
ed-measuring instruments, frequency meters, slid-
g-contact rheostats

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tomatic bin level indication & control

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nses, prisms & filters. Glass of every description

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chester, N. Y.
ological supplies

her Corp., 5087 Huntington Dr., Los Angeles 32,
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ectromagnetic relays

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wson, Md.
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artz piezo-electric crystals

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strument covers of transparent fabrics

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ichsen sheet metal testing machine

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Brookfield Engineering Laboratories, Sharon, Mass.
Synchro-lectric viscosimeter

Brooklyn Thermometer Co., Meriden, Conn.
Thermometers & hydrometers

Brown Corp., W. R., 5728 Armitage Ave., Chicago 39, Ill.
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Brown Geophysical Co., P. O. Box 6005, Houston, Tex.
Instruments for measuring earth's gravitational field

Brown Instrument Company, 4482 Wayne Ave., Philadelphia, Pa.
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Buffalo Apparatus Corp., 180 Main St., Buffalo, N. Y.
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Bunnell & Company, J. H., 215 Fulton St., New York, N. Y.
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Burgess Battery Co., 500 W. Huron St., Chicago, Ill.
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Burrell Technical Supply Co., 1942 Fifth Ave., Pittsburgh, Pa.
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Burt Scientific Labs., R. C., 1212 E. Green St., Pasadena, Calif.
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Burton-Rogers Co., 857 Boylston St., Boston, Mass.
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Bushnell and Nevius, 913 N. LaCienega Blvd., Los Angeles, Calif.
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Cambridge Instrument Co., Inc., Grand Central Terminal, New York, N. Y.
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Farrel-Birmingham Co., Inc., 25 Main St., Ansonia, Conn.
Calipers for checking roll diameters & gear tooth comparators

Fassett Co., Inc., C. M., 209 North Wall St., Spokane, Wash.
Laboratory supplies

Fecker, J. W., 2016 Perrysville Ave., N. S., Pittsburgh, Pa.
Astronomical instruments

Federal Anti-Capacity Switch Corp., 1200 Niagara St., Buffalo, N. Y.
Anti-capacity switches

Federal Tool Corporation, 408 North Leavitt St., Chicago, Ill.
Gages, fixtures, dies & special tools

Federal Pneumatic Systems, Inc., 127 N. Dearborn St., Chicago, Ill.
Particle size classifiers

Federal Products Corp., 1144 Eddy St., Providence, R. I.
Precision measuring instruments

Federal Telegraph Co., Inc., 200 Mt. Pleasant Ave., Newark, N. J.
Radio transmitting and direction finding equipment, transmitting tubes, field intensity meters, high speed engine indicators

Fee and Stemwedel, Inc., 1954 No. Western Ave., Chicago, Ill.
Dial type thermometers, barometers, humidity indicators & allied products, field glasses & binoculars

Fellows Gear Shaper Co., Springfield, Vt.
Gear checking machines & involute measuring machines

Felsenthal & Sons, G., 4110 W. Grand Ave., Chicago 51, Ill.
Dial faces & pointers, name plates, instruction plates & computing scales

Fenwal, Inc., 3 Main St., Ashland, Mass.
Industrial thermostats

Ferner Co., R. Y., 131 State St., Boston, Mass.
Precision instruments

Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Electrical instruments

Ferris Instrument Corp., Boonton, N. J.
Laboratory & production testing equipment, radio noise & field strength meters & special electrical instruments

Fidelity Machine Co., 3906 Frankfort Ave., Philadelphia, Pa.
Abrasion testers

Field Electrical Instrument Co., 2432 Grand Concourse, New York, N. Y.
Electrical instruments

Fink-Roseliere Co., Inc., 109 W. 64th St., New York, N. Y.
Thermometers

Fischer & Porter Co., 37 County Line Road, Hatboro, Pa.
Rotameters, sight flow meters, automatic flow controllers, precision optical cells, precision bore glass tubing, & special precision glass apparatus.

Fish-Schurman Corp., 230 East 45 St., New York, N. Y.
Scientific instruments, optical, technical & scientific glassware & porcelain

Fisher Governor Co., Marshalltown, Iowa
Motor control valves & regulators

Fisher Research Laboratory, 1961 University Ave., Palo Alto, Calif.
Leak detector & pipe finder. Electronic equipment

Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
Standard & special equipment & instruments for chemical, biological & metallurgical laboratories

Fleischhauer & Son, Frank, 89-36 187 Place, Hollis, L. I., N. Y.
Instrument makers

Fluid Meters, Inc., 44 Wall St., Room 1101, New York, N. Y.
Positive displacement meters, 1/10 to 8 gallons per hour with gravity pressures

Ford Meter Box Co., Wabash, Indiana
Water meter testers

Ford Motor Company, 3674 Schaefer Rd., Dearborn, Mich.
Johansson gage blocks & accessories such as parallels, adjustable holders, scribers, straight edges, center points, sine bars

Ford Regulator Valve Co., 403 Broome St., New York, N. Y.
Regulating valves

Foster Engineering Co., 109 Monroe St., Newark, N. J.
Control valves

Fox Munitions Corp., 21st & Arch Sts., Philadelphia, Pa.
Gages & gaging fixtures

Foxboro Co., 46 Neponset Ave., Foxboro, Mass.
Indicating, recording & controlling instruments for pressure, temperature, humidity, level & flow

Freas Glass Works, Francis L., Conshohocken, Pa.
Hydrometers, thermometers & glass instruments

Fredericks Co., George E., Bethayres, Pa.
Glass instruments & apparatus

Frick Co., Inc., Waynesboro, Pa.
Float valve controls & electric controls, refrigerating & air conditioning machinery

Fried & Lustig, Inc., 31 Union Square, New York, N. Y.
Thermometers

Friez & Sons, Division, Julien P., Bendix Aviation Corp., Taylor Ave. at Loch Raven Blvd., Towson, Md.
Temperature & humidity controls, gas & stoker controls, damper motors, electrical relays, temperature & humidity indicators & recorders, psychrometers, draft gages, anemometers, CO_2 analyzers

Fuess, Inc., R., 39 West 60th St., New York, N. Y.
Scientific instruments

Fuller Co., 110 Bridge St., Catasauqua, Pa.
Bulk material level controllers

Fulton Sylphon Co., Knoxville, Tenn.
Temperature & pressure regulators, sylphon bellows; thermostat assemblies; diesel controls; automobile thermostats; air conditioning controls

Furnas Electric Co., 811 South 72nd St., West Allis, Wis.
Pressure controls

G

Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
Measuring instruments including toolmaker microscopes, micrometer slides, micrometer microscopes, comparators, interferometers, spherometers, microscopes & telescopes for observation & inspection; time recording devices including chronographs & special devices; dividing machines for engraving linear & circular scales; goniometers; spectroscopic equipment & accessories

Gallien, R. P., 220 W. 5 St., Los Angeles 13, Calif.
Instrument lathes & tools

Garner Electronics Corp., 1100 Washington Blvd., Chicago 7, Ill.
Frequency meters and slide projectors

Gas Appliance Specialties Co., 57th St., bet. Northern Blvd. & 32nd Ave., Woodside, New York, N. Y.
Gas regulators

Gates & Co., Geo. W., Franklin Sq., Long Island City, N. Y.
Light sources & etching compounds for glass & quartz

Gauthier, Donat A., 7408 Poe Ave., Detroit, Mich.
Gasoline measuring devices & automobile service station testers

Geier & Bluhm Inc., 607 River St., Troy, N. Y.
Mechanical devices & spirit level vials

Genales, Andrew, 29 Second Ave., Nyack, N. Y.
Toolroom test indicators

General Biological Supply House, Inc., 761 East 69th Pl., Chicago, Ill.
Biological laboratory supplies

General Combustion Corp., 2218 W. Lake St., Chicago, Ill.
Combustion equipment

General Controls Co., 801 Allen Ave., Glendale 1, Calif.
Pressure, temperature & flow control valves

General Electric Co., 1 River Rd., Schenectady, N. Y.
Electrical instruments & meters

General Electric Co., Lamp Dept., Nela Park, Cleveland, Ohio
Lighting sources

General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Medical, dental & industrial X-ray apparatus, accessories & suppliers

General Engg. & Model Works, 421 N. Braddock Ave., Pittsburgh, Pa.
Gages & precision measuring instruments for checking threaded tubular products

General Luminescent Corp., 638 Federal St., Chicago, Ill.
Luminous paint, fluorescent dials & pointers, radioactive dials & pointers, phosphorescent dials & pointers

General Physical Laboratory, 509 Fifth Ave., New York, N. Y.
Special light sources

General Radio Co., 30 State St., Cambridge, Mass.
Radio & electrical measuring instruments for laboratory & industrial use: stroboscopes, noise measuring equipment, measuring & test equipment for electrical communication systems

General Regulator Corp., 165 Broadway, New York, N. Y.
Combustion, draft, liquid level & pressure controls

General Sales & Products Corp., 45 Mohawk St., Cohoes, N. Y.
Shut-off valves

General Scientific Corp., 4829 So. Kedzie Ave., Chicago, Ill.
Lenses & photoelectric cells

General Television Corp., 70 Brookline Ave., Boston, Mass.
Ionization vacuum gages

General Test Equipment Co., 38 Argyle Park, Buffalo 9, N. Y.
Pen size radio signal source, also special apparatus

Geophysical Instrument Co., Arlington, Va.
Instruments & accessories for prospecting for oil, minerals, water, bedrock; also equipment for making measurements in wells

G. & G. Precision Works, Inc., 5-33 Forty-eighth Ave., Long Island City 1, N. Y.
Mechanical, optical & electrical precision instruments

Gilmore, E. R., Box 5718, Homewood Sta., Pittsburgh, Pa.
Gas leak stethoscopes

Gilmore Drug Co., W. J., 422 Blvd. of Allies, Pittsburgh, Pa.
Laboratory supplies

Gisholt Machine Co., Madison, Wis.
Static & dynamic balancing machines

Gleason-Avery, Inc., 27 Clark, Auburn, N. Y.
Furnace controls

Glendale Optical Co., 249 Pennsylvania Ave., Brooklyn, N. Y.
Prisms, lenses, flats, mirrors, verticles & optical units

Globe Industries, Inc., 125 Sunrise Place, Dayton,
Aircraft instrument testing equipment, aircraft
terval timing instruments, aircraft photo equipm
automatic control instruments

Globe Phone Mfg. Corp., Reading, Mass.
Pipe locating equipment, leaky valve locators,
ing aids, secret phone or listening equipment
government investigating agencies

Globe Tool & Engg. Co., 410 Davis Ave., Day
Ohio
Dynamic balancing equipment

Glogau & Co., 1632 Rand McNally Bldg., Chic
Ill.
Calipers

G-M Laboratories, Inc., 4326 N. Knox, Chicago,
Photoelectric cells, photoelectric relays, slide
rheostats, galvanometers, laboratory stands & cl

G. M. Manufacturing Co., 248 Lafayette St.,
York, N. Y.
Thermometers, hydrometers, psychrometers, hyg
eters

Goerz American Optical Co., C. P., 317 East
St., New York, N. Y.
Photographic lenses, optical prisms & flats,
other optical units to specification

Goetze Niemer Co., 808 Francis St., St. Joseph,
Laboratory supply house

Gogan Machine Corp., 1440 E. 55 St., Clevel
Ohio
Automatic hardness testers

Goldak Co., 1544 W. Glenoaks Blvd., Glendale
Calif.
Surveying instruments, pipe locators, leak detec

Goodrich Co., B. F., 450 South Main St., Ak
Ohio
Vibration absorbers

Gordon Co., Claud S., 3000 S. Wallace St., Chic
Ill.
High temperature equipment accessories, such
thermocouples, thermocouple wire, lead wire,
sulators

Gorrell & Gorrell, Chicago Heights, Ill.
Equipment for biological & psychological work

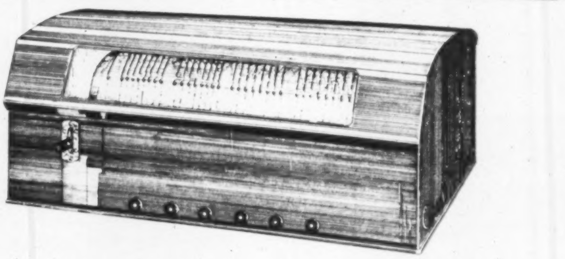
Gotham Instrument Co., 149 Wooster St., New Y
N. Y.
Indicating, dial & recording thermometers

Gotham Scientific Co., 106 Water St., New Y
N. Y.
Laboratory supplies

Gothard Mfg. Co., 1355 N. 9 St., Springfield, Ill.
Dial lights

Gow-Mac Instrument Co., 22 Lawrence St., Newa
N. J.
Thermal conductivity gas analyzers & gas analy
cells

Graver Tank & Mfg. Co., Inc., East Chicago, Ind.
Automatic proportioning feeders



ELECTRIX REKORDER

The most versatile Chronograph. Invaluable for graphic recording in . . . production . . . control . . . biology . . . research . . . timing . . . and any qualitative phenomenon. Synchronous drive for "dead-beat" accuracy. Nine remarkable speeds. FOB factory, either type $245.00

DRUM TYPE. All-aluminum drum holds chart paper 25 cm by 50 cm. Supplied with up to 50 stylui to provide 50 simultaneous recordings. Drum turns one revolution (50 cm of chart) at any of the easily selected speeds of 1 min. . . . 5 min. . . . 15 min. . . . 1 hr. . . . 4 hrs. . . . 12 hrs. . . . 1 day . . . 1 week . . . 4 weeks. By use of low-cost screw-feed attachment a single continuous spiral recording up to 2,500 cm. long (80 ft.) may be had on single chart.

CONTINUOUS ROLL TYPE. Employs roll of recording paper from 5 to 25 cm. (2" to 10") wide in lengths up to 125 feet. Same nine speeds. By using widest paper and 50 styli, more than a mile of graphic can be done, unattended, on a single roll.

On either type of Rekorder, any conventional type of recording system can be used with proper instruments such as magnet energized pencil or inked pens or using pressure sensitive waxer paper. However, the Rekorders are supplied complete with styli for use with Electrix paper which instantly and permanently records when a small current passes thru the stylus onto the paper. Write for details about the Rekorders . . . about Electrix paper . . . about the MONODRUM chart mover with 22 speeds . . . and about the DUALDRUM chart mover with 36 speeds and overall speed ratio of from 1:1 to 1:10,000,000!

Correll & Correll
Chicago Heights,
Illinois

ay Instrument Co., 64½ W. Johnson St., Philadelphia, Pa.
Scientific instruments

reen, Henry J., 1191 Bedford Ave., Brooklyn, N. Y.
Meteorological instruments

reene Bros., Inc., 1810 Griffin St., Dallas, Texas
Laboratory Supplies

reenfield Tap & Die Corp., Greenfield, Mass.
Machine shop gages

reiner, Inc., Emil, 55 Vandam St., New York, N. Y.
Laboratory Supplies

riebel Co., E., 8 Wayne St., Carbondale, Pa.
Thermometers, hydrometers, chemical & laboratory glassware

riner Co., A. J., 417 East 13th St., Kansas City, Mo.
Laboratory supplies

ove Regulator Co., 1729 Poplar St., Oakland, Calif.
Pump governors, pressure reducing & back pressure regulators for gas or liquid pressures to 6000 lbs.

uardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
A-c. and d-c. relays

ump Co., B. F., 435 S. Clinton St., Chicago, Ill.
Scales

urley, W. & L. E., 514 Fulton St., Troy, N. Y.
Surveying & allied engineering instruments, paper testing & aeronautical navigation instruments & standard weights & measures

H

agan Corp., 600 Bowman Bldg., Pittsburgh, Pa.
Combustion control equipment

agedorn Engineering Co., 8162 Beverly Blvd., Los Angeles, Calif.
Aircraft instruments

aines Gauge Co., 119 South 4th St., Philadelphia, Pa.
Dial micrometer gage

ankscraft Co., 1007 E. Washington Ave., Madison, Wis.
Timers

alldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Laboratory transformers

alliburton Oil Well Cementing Co., Duncan, Okla.
Oil well surveying instruments

amilton Mfg. Co., Two Rivers, Wis.
Laboratory furniture

amilton Watch Co., Lancaster, Pa.
Chronometers & watches

anlon-Waters, Inc., Box 1559, Tulsa, Okla.
Pressure & level controls, time cycle controllers

annifin Mfg. Co., 621 So. Kolmer Ave., Chicago, Ill.
Valve operating devices

anovia Chemical & Mfg. Co., 90 Chestnut St., Newark, N. J.
Quartz mercury arc lamps

ardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
Resistors

art Manufacturing Co., 110 Bartholomew Ave., Hartford, Conn.
Thermostats, remote control switches, magnetic relays, heater switches, motor control switches, mercury tube relays

art Mfg. Co., R. E., 416 Ward Bldg., Battle Creek, Mich.
Production counters

art Moisture Gauges, Inc., 126 Liberty St., New York, N. Y.
Kaydel moisture gages.

asler-Tel Co., 30 Vesey St., New York, N. Y.
Speed indicators, portable, chronometric

athaway Instrument Co., 1315 S. Clarkson St., Denver, Colo.
Instruments & apparatus for electrical & mechanical measurements & control.

ausser & Son, C. A., 6040 Belfield Ave., Philadelphia, Pa.

aydon Mfg. Co., Forestville, Conn.
Relays

ayes Scientific Appliances, 202 N. Broadway, Urbana, Ill.
Scientific instruments

ays Corp., P. O. Box 299, Michigan City, Ind.
Combustion instruments & automatic combustion controls

ayward, H. N., 612 W. Oregon St., Urbana, Ill.
Tachometer Testers

-B Electric Co., 6122 N. 21 St., Philadelphia, Pa. phia, Pa.
Mercury tube relays

-B Instrument Co., Inc., 2501 N. Broad St., Philadelphia, Pa.
Thermometers & hydrometers, remote control equipment

D Electric Co., 100 W. Monroe St., Chicago, Ill.
Split core ammeters

ebler Co., W. O., Central at Long Ave., Hillside, N. J.
Electrical gas analyzers

ell Corporation, 216 S. 4 St., St. Louis, Mo.
Laboratory Supplies

elland Research Corp., 700 Club Bldg., Denver, Colo.
Geophysical instruments, photoflash synchronizers, gas detectors, oscillographs, strain gages, vibration detectors, recording cameras & industrial instruments

Heise Bourdon Tube Co., 275 Noble Ave., Bridgeport, Conn.
Bourdon tube devices

Hellige, Inc., 3718 Northern Blvd., Long Island City, N. Y.
Scientific instruments, laboratory & bacteriological supplies

Henderson & Co., H. B., East Liverpool, Ohio
Pyrometric cones

Henschel & Co., Inc., John, 105 E. 29th St., New York, N. Y.
Drawing instruments

Henson Co., Fred C., 3311 E. Colorado St., Pasadena, Calif.
Electroscope

Henszey Co., Watertown, Wis.
Feed water meters, flow indicators continuous blowdown, heat exchangers and boiler feed regulators. Also meters and flow indicators for corrosive chemicals

Herkimer Tool & Model Works, 119 George St., Herkimer, N. Y.
Sine bars & gaging fixtures

Heusser Instrument Mfg. Co., 134 West Second South St., Salt Lake City, Utah
Analytical balances

Hewlett-Packard Co., 481 Page Mill Road, Palo Alto, California
Electronic equipment

Heyman Co., 157 Chambers St., New York, N. Y.
Inspection Instruments

H & H Thermostats, Inc., 682 Broadway, New York, N. Y.
Altimeters, recording thermometers, recorder ink for extreme temperatures

Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Electric indicating instruments

Higgins Co., Charles F., RFD 2, Box 61, So. Portland, Me.

Hoffman Co., S. O., 835 Howard St., San Francisco, Calif.
Bolometers

Hoke, Inc., 585 Eagle Ave., New York, N. Y.
Regulators

Hollywood Electronics Div., Megard Corp., 1601 S. Burlington St., Los Angeles, Calif.
Electrical instruments, oscillators & amplifiers

Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles 36, Calif.
Chokes, filter & transformers for radio & communications

Holtzer-Cabot Electric Co., 125 Amory St., Boston, Mass.
Fractional Horsepower Motors

Hopp Press, Inc., 460 W. 34 St., New York, N. Y.
Nameplates, dial faces, scales, instruction plates

Hoskins Mfg. Co., 4445 Lawton Ave., Detroit, Mich.
Thermo-couples, heating elements, pyrometers & electric furnaces

Howard Clock Products, Inc., 256 Charles St., Waltham, Mass.
Observatory & seismological clocks.

Howe & French, Inc., 99 Broad St., Boston, Mass.
Laboratory supplies

Howe Scale Co., Rutland, Vt.
Scales

Humboldt Mfg. Co., 2014 N. Whipple St., Chicago, Ill.
Cement & concrete testers

Hunt & Son, C. B., Salem, Ohio
Valves & valve operating devices.

Hydraulic Controls, Inc., 122 Michigan Ave., Chicago, Ill.
Hydraulic control systems

Hydraulic Press Co., Mount Gilead, Ohio
Pressure controls

Hy Ef Electrical Products Mfg. Co., 1515 West Pico, Los Angeles, Calif.
Automobile service station instruments

I

Ideal Commutator Dresser Co., 1420 Park Ave., Sycamore, Ill.
Insulation testers & revolution counters

Ideal Laboratory Tool & Supply Co., P.O. Box 193, Cheyenne, Wyo.
Aircraft instrument test apparatus, sensitive needle valves

Illinois Engineering Co., Racine Ave. & 20th Pl., Chicago, Ill.
Regulating valves

Illinois Tool Works, 2501 N. Keeler Ave., Chicago, Ill.

Illinois Testing Laboratories, Inc., 142 West Hubbard St., Chicago, Ill.
Indicating pyrometers, resistance thermometers, pyrometer controllers, air velocity meters, metal detectors

Impact Register Co., 315 So. Neil St., Champaign, Ill.
Instruments for determining and recording impacts received by railroad cars and riding qualities of railroad cars, automobiles

Indiana Steel Products Co., 6 N. Michigan Ave., Chicago 2, Ill.
Instrument magnets

Indicating Calipers Corp., 506 East 19th St., New York, N. Y.
Indicating calipers

Industrial Condenser Corp., 1725 W. North Ave., Chicago 22, Ill.
Oil, paper & electrolytic capacitors

Industrial Engineering Corp., Evansville, Ind.
Relays

Industrial Filter & Pump Mfg. Co., 3017 W. Carroll Ave., Chicago, Ill.
Salt spray testers

Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Electrical measuring & test equipment

Industrial-Scientific Supply Co., 828½ Monroe St., Fort Worth, Texas
Laboratory Supplies

Industrial Timer Corp., 101 Edison Place, Newark, N. J.
Industrial Timers, motor driven, with automatic reset. Controllers, signals, testing equipment for electrical parts (operation or life test)

Industrial X-Ray Co., 1613 Second Ave., Seattle, Wash.
X-Ray equipment & X-ray inspection service

Inferno Co., Box 1138, Shreveport, La.
Combustion instruments

Instrument Resistors, Inc., 25 Amity St., Sengac, N. J.
Instrument resistors

International Business Machines Corp., 590 Madison Ave., New York, N. Y.
Scales & time instruments

International Equipment Co., 352 Western Ave., Brighton, Boston, Mass.
Analytical centifuges

Infilco Inc., 325 W. 25th Place, Chicago, Ill.
Hydraulic measurement & control & chemical feeding & proportioning.

International Register Co., 2620 W. Wash. Blvd., Chicago, Ill.
Coin meters—timers for electric ranges & gas ovens.

International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Metallized & wirewound fixed & variable resistors including high voltage & high frequency types.

J

Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Radio testing equipment

Jackson, H. Douglas, 851 E. Orange Grove Ave., Pasadena, Calif.
Anenometers

Jacobs Bros. Co. Inc., 1 Main St., Brooklyn, N. Y.
Scales

Jaeger Watch Co., Inc., 304 East 45th St., New York, N. Y.
Automobile clocks, timepieces for aviation and marine, chronometric tachometers & true airspeed indicators

Jansson Gage Co., 19206 Glendale Ave., Detroit 23, Mich.
Gages, machinists'

Jardur Import Co., 21 W. 19th St., New York, N. Y.
Chronographs & stop-watches

Jarrell-Ash Co., 165 Newbury St., Boston, Mass.
Representatives for Adam Hilger, Ltd., manufacturers of optical instruments

J B L Instrument Co., 228 Hazelwood Ave., Alden, Pa. Clifton P. O.
Rotary instrument switches, transformer tapping, railway signal gear, decade resistance boxes

J-B-T Instruments, Inc., 441 Chapel St., New Haven, Conn.
Electrical measuring & controlling instruments: pyrometers, thermocouples, selector switches, potentiometers, resistance thermometers, laboratory instruments

Jeffrey Mfg. Co., Columbus, Ohio
Weighting, feeding, batching & proportioning equipment

Jenkins Bros., 80 White St., New York, N. Y.
Regulating valves

Jewett Refrigerator Co., 226 Letchworth St., Buffalo, N. Y.
High altitude test & calibration chambers

Johnson Service Co., 507 E. Michigan St., Milwaukee, Wisc.
Automatic temperature & humidity control for heating, cooling, ventilating, air conditioning & industrial processes

Johnson-Williams, Ltd., Box 8, Palo Alto, Calif.
Combustible gas indicators & alarm systems, portable & continuous, including accessories

Johnston Manufacturing Co., 2823 E. Hennepin Ave., Minneapolis, Minn.
Furnace controls

Jones, Howard B., 2460 W. George St., Chicago 18, Ill.
Connectors

Jones & Lamson Machine Co., Clinton & Whitmore Sts., Springfield, Vt.
Optical comparators

Jones Motrola Sales Co., 432 Fairfield Ave., Stamford, Conn.
Tachometers, speed indicators & speedometers

Jorgan Co., 65 Atlantic Ave., Rochester, N. Y.

Judson Governor Co., 38 Browns Race, Rochester, N. Y.
Governors

K

Kansas City Laboratory Supply Co., 1434 Wyandotte St., Kansas City, Mo.
Laboratory supplies

Karp Metal Products Co., Inc., 129 - 30th St., Brooklyn, N. Y.
Instrument panels

Kauffman-Lattimer Co., 263 N. Front St., Columbus, Ohio
Laboratory Supplies

Keller Mfg. Co., G. P., 2803 Colorado Ave., Santa Monica, Calif.
Balances & weights of precision

Kelley-Koett Mfg. Co. Inc., Covington, Ky.
X-Ray apparatus

Kellogg Switchboard & Supply Co., Clearing Station, Chicago, Ill.
Relays

Kenyon Instrument Co., Inc., 1345 New York Ave., Huntington, L. I., N. Y.
Airport & marine instruments

Kern Co., 136 Liberty St., New York, N. Y.
Surveying & astronomical instruments

Kessler Co., Walter H., 128 Water St., New York, N. Y.
Thermometers and hydrometers

Kester Solder Co., 4216 Wrightwood Ave., Chicago, Ill.
Cored solders

Keuffel & Esser Co., Adams & Third Sts., Hoboken, N. J.
Surveying instruments

Kewaunee Mfg. Co., End of So. Center St., Adrian, Mich.
Laboratory furniture

Kieley & Mueller, Inc., 2013-2033—43 St., North Bergen, N. J.
Pressure regulating & flow control devices

Kimball Co., W. W., 420 Kimball Bldg., Chicago, Ill.
Laboratory furniture

Kimble Glass Co., Vineland, N. J.
Glass apparatus, glass tubing, thermometers, hydrometers

King, Andrew, 521 Broad Acres Road, Narberth, Pa.
Portable Brinell Hardness Tester

King Engineering Corporation, 942 Gordon Ave., Ann Arbor, Mich.
Liquid level indicators, distant reading

Kirk & Blum Manufacturing Co., 2838 Spring Grove Ave., Cincinnati, O.
Instrument panels and sheet metal assemblies

Klett Mfg. Co., 179 E. 87th St., New York, N. Y.
Colorimeters

Klingerit, Inc., 16 Hudson St., New York, N. Y.
Liquid level gages

Klipfel Mfg. Co., 2641 W. Harrison St., Chicago, Ill.
Regulating valves

Knickerbocker Development Corp., 116 Little St., Belleville, N. J.
Automatic testing apparatus, electrical instruments, stroboscopes

Knopf, Paul, 43 Ave. & 37 St., Long Island City, N. Y.
Registering instruments for vehicles

Knowles Scale Works, Lowell, Mass.
Platform, counter & beam scales

Koch & Co., F. A., 72 Spring St., New York, N. Y.

Kold-Hold Mfg. Co., 424 N. Grand Ave., Lansing, Mich.
High altitude test & calibration chambers

Kolesch & Co., 138 Fulton St., New York, N. Y.
Surveying instruments

Kollmorgen Optical Co., 767 Wythe Ave., Brooklyn, N. Y.
Astronomical & optical instruments

Kollsman Instrument Div., Square D Co., 8008 - 45th Ave., Elmhurst, Long Island, N. Y.
Precision instruments for aircraft

Kron Co., Bridgeport, Conn.
Scales

Krouse Testing Machine Co., 101 E. Dominion Blvd., Columbus, Ohio
Fatigue testing machines

Kuner Co., Max, 804 First Ave., Seattle, Wash.
Nautical instruments

Kurman Electric Co., Inc., 3518-37 St., Long Island City, New York
Relays, electrical test equipment, hearing devices

L

L. A. B. Corp., P. O. Box 162, Summit, N. J.
Special instruments

Laboratory Construction Co., 1113-15 Holmes St., Kansas City, Mo.
Laboratory furniture & apparatus

Laboratory Equipment Corp., 720 E. Main St., Benton Harbor, Mich.
Carbon & sulphur determinators

Laboratory Furniture Co., Inc., 37-18 Northern Blvd., Long Island City, N. Y.
Laboratory furniture

Laboratory Materials Co., 7319 Vincennes Ave., Chicago, Ill.
Laboratory supplies

Laboratory Specialties, Inc., 130 S. Wabash St., Wabash, Ind.
Mirrors—front surfaces & aluminized; Monochromatic light sources, Black light apparatus, Diffraction gratings, Spectroscopes, Fluorescent & phosphorescent materials

Lackner Co., Lackner Bldg., Cincinnati, O.
Aviation instruments

Lambert Meter Co., Inc., Plainfield, N. J.
Gas meters

Lammert & Mann Co., 260 N. Woods St., Chicago, Ill.
Flow regulators & valves

LaMotte Chemical Products Co., McCormick Bldg., Baltimore, Md.
Hydrogen ion apparatus

Lampkin Laboratories, Bradenton, Fla.
Radio-frequency meters

Landis & Gyr, Inc., 104 Fifth Ave., New York, N. Y.
Electric integrating meters; indicating & graphic demand meters for KW, KVA, reactive; prepayment meters; totalizing & remote; time switches; motor wound escapement or synchronous motor types with astronomic dials; miniature ball bearings

Lane Wells Co., 5610 So. Soto St., Los Angeles, Calif.
Oil well testing instruments

Lantz-Phelps Corp., 420 Linden Ave., Dayton, Ohio
Automotive test instruments

La Pine & Co., Arthur S., 114 W. Hubbard St., Chicago, Ill.
Laboratory supplies

Larrimore Sales Co., P.O. Box 1234, St. Louis 1, Mo.
Magnifiers

Lavoie Laboratories, Morganville, N. J.
Ultra high frequency precision frequency meter

Lawrence & Hill, Inc., 142 Main Ave., Watertown, N. Y.
Gages & gaging fixtures

Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Calif.
Relays

Lear Avia, Inc., Piqua, Ohio
Aircraft controls, aircraft communication equipment, transmitters, receivers, & direction finders

Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Electrical measuring instruments for both laboratory & plant. For laboratory: bridges, galvanometers, potentiometers, photometric equipment, test sets & standards. For plant: indicators, recorders & controllers for chemical concentration, CO_2, current, electrolytic conductivity, frequency, gas analysis, humidity, Kw, Rkva, light, electrical load, pH, pressure, pyrometry, radiation, smoke density, speed, temperature, voltage. Speedomax Recorders, Centrimax Flowmeters & Metermax Combustion control Systems

Leitz, Inc., E., 730 Fifth Ave., New York, N. Y.
Optical instruments

Lektra Labs., Inc., 30 E. 10 St., New York, N. Y.
Timing devices

Lenox Instrument Co., 2010 Chancellor St., Philadelphia, Pa.
Optical and technical instruments

Leslie Co., Lyndhurst, N. J.
Pressure reducing valves, pump governors, temperature regulators

Leupold & Stevens Instruments, 4445 N. E. Gilson St., Portland, Ore.
Recorders & indicators, for irrigation, power, waterworks, sewerage. Equipment for hydraulic laboratories. Snow-rain recorders, hydrographic accessories, transits, levels

Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Portable pyrometers, potentiometers, resistance thermometers & other electrical temperature measuring devices

Lewyt Metal Products, 60 Broadway, Brooklyn, N. Y.
Instrument housings

Lincoln Park Tool & Gage Co., Lincoln Park, Mich.
Precision inspection equipment

Lindberg Engineering Co., 2450 W. Hubbard St., Chicago, Ill.
Electric power input controls

Link Aviation Devices, Inc., Binghamton, N. Y.
Aircraft navigational instruments

Link Engineering & Mfg. Co., 13845 Elmira St., Detroit, Mich.
Spring testers

Lipman Engineering Co., 415 Van Braam St., Pittsburgh, Pa.
Photoelectric counters

Liquidometer Corp., 36-16 Skillman Ave., Long Island City, N. Y.
Liquid level gages

Littelfuse, Inc., El Monte, Calif.
Low range precision fuses & fuse mountings

Lord Mfg. Co., 1635 W. 12 St., Erie, Pa.
Bonded rubber vibration isolation mountings & flexible couplings for practical horsepower motors

L & R Manufacturing Co., 577 Elm St., Arlington, N. J.
Instrument cleaning machines & cleaning & rinsing solutions. Crystal cement

Luers, J. Milton, 12 Pine St., Mt. Clemens, Mich.
Timers

Lufkin Rule Co., Saginaw, Mich.
Precision tools & measuring tapes

Lumenite Electric Co., 37 West Van Buren St., Chicago, Ill.
Photoelectric controls

Lundquist Tool & Mfg. Co., 57 Jackson St., Worcester, Mass.
Ammeters

Lux Clock Mfg. Co., Inc., 95 Johnson St., Waterbury, Conn.
Automatic timers & clock mechanisms

M

Macbeth Daylighting Corp., 227 West 17th St., New York, N. Y.
Daylight Lamps for titration & color matching

Machlett & Son, E., 220 East 23rd St., New York, N. Y.
Laboratory apparatus & supplies

Magnaflux Corp., 5908 Northwest Highway, Chicago, Ill.
Magnetic inspection equipment

Magnatrol Valve Corp., 52 Beekman St., New York, N. Y.
Valves

Magnavox Co., Inc., Fort Wayne, Indiana
Electrolytic capacitors

Magnetic Analysis Corp., 42-44 12th St., Long Island City, N. Y.
Magnetic inspectors for uniform cross-sectional steel

Magnetic Gauge Co., 60 E. Bartges St., Akron, Ohio
Continuous gages, sheet & strip

Mahady Co., E. P., 857 Boylston St., Boston, Mass.
Laboratory apparatus

Mallory & Co., Inc., P. R., Indianapolis, Ind.
Capacitors, relays & switches

Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Thermometers, glass, dial & recording; contrographs; indicating & recording controllers; diaphragm motor valves; tachometers, barometers; & hygrometers

Marine Compass Co., Pembroke, Mass.
Marine instruments

Maris Co., John M., 528 Arch St., Philadelphia, Pa.
Laboratory apparatus

Marsh Corp., Jas. P., 2073 Southport Ave., Chicago, Ill.
Indicating gages, recording gages, dial thermometers, recording thermometers, refrigeration service instruments, temperature controlling systems, valves for heating systems

Marshall Co., C. & E., 1445 West Jackson Blvd., Chicago, Ill.
Manufacturers & distributors of jewelers, watchmakers & engravers supplies

Marshalltown Mfg. Co., Marshalltown, Iowa
Pressure gages & indicating thermometers

Marston Co., C. A., 506 Washington St., Braintree, Mass.
Time study instruments

Martindale Electric Co., Box 2669, Lakewood Branch, Cleveland, Ohio
Insulation testers

Martin-Decker Corp., 3431 Cherry Ave., Long Beach, Calif.
Torque gages & pull rod dynamometers

Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.
Industrial control equipment for pressure temperature, flow, liquid level, combustion & ratio: diaphragm control valves; pressure & vacuum regulators; level controllers; pump speed governors; pump pressure regulators; pipe strainers

Maymer Corp., 10886 Berea Rd., Cleveland 8, Ohio
Scales, dials & templates

McAlear Mfg. Co., 1901 S. Western Ave., Chicago, Ill.
Manual & automatic controls for air, oil gas, steam, chemicals, pure food, acid & alkali

McCord Radiator & Mfg. Co., 2585 E. Grand Ave., Detroit, Mich.
Liquid meters for low flows

McCorkle Co., D. H., 6th & Bancroft Way, Berkeley, Calif.
Thermostats & electric gas valves

McDonnell & Miller, Room 1316, Wrigley Bldg., Chicago, Ill.
Boiler controls

McDonnell Odometer Co., 3501 So. Kedzie Ave., Chicago, Ill.
Counters

McFarlin Co., 29 West Marion Ave., Youngstown, Ohio
Leak detectors

McKesson-Doster-Northington Co., 1706 First Ave., Birmingham, Ala.
Laboratory supplies

McNab of Bridgeport, Inc., Bridgeport, Conn.
Marine appliances, torsionmeters, salinity indicators, revolution counters

McNeill Engineering Equipment Co., T. W., 40 West Van Buren St., Chicago, Ill.
Smoke alarms

Measurements Corp., Boonton, N. J.
Radio Frequency Testing & Measuring Devices

Mellophone Corp., 714 University Ave., Rochester, N. Y.
Rectifiers

Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Automatic controls for heating, refrigeration, air conditioning, & various industrial applications

Merco Nordstrom Valve Co., 400 Lexington Ave., Pittsburgh, Pa.
Control valves & valve position indicators

Merron Regulator Co., 2357 N. 29th St., Milwaukee, Wis.
Power plant specialties in regulation of pressure, level, rate of flow, proportioning & temperature

Meriam Instrument Co., 10920 Madison Ave., Cleveland, Ohio
Manometers, draft gages, indicating flow meters for steam, oil, gas, air, water, tank liquid level gages

Meridian Instrument Co., 303 Fourth Ave., New York 10, N. Y.
Chronometers

Merit Coil & Transformer Corp., 311 N. Desplaines St., Chicago 6, Ill.
Transformers, coils & reactors, electrical windings

Merz Engineering Co., Indianapolis 7, Ind.
Gages & gaging fixtures

Merkle-Korff Gear Co., 214 North Morgan St., Chicago, Ill.
Motorized speed reducers: induction, synchronous, reversing, d-c., universal motors

Merrick Scale Mfg. Co., Autumn St., Passaic, N. J.
Automatic continuous weighing machines

Merritt Engg. & Sales Co., Inc., 120 So. Niagara St., Lockport, N. Y.
Consistency controls

Metron Instrument Co., 432 Lincoln St., Denver, Colo.
High frequency amplifiers, electric instruments, oscillators, radio remote control systems, comparator gages, electric tachometers, timers, chronographs

Meter Devices Co., 1001 Prospect Ave., S. W., Canton, Ohio
Electrical test devices

Metzger & Son, F. F., 2600 N. 6 St., Philadelphia, Pa
Extensometers

Meyer, Max, 76 Willoughby St., Brooklyn, N. Y.
Laboratory apparatus

Meyer Governor Co., 284 Baker Bldg., Minneapolis, Minn.
Long-distance recording, indicating, and contact-making instruments; gage pulsation protectors

Meylan, A. R. & J. E., 264 West 40th St., New York, N. Y.
Stop watches

M-G Gage Co., 107 Franklin St., Syracuse, N. Y.
Snap gages

Mico Instrument Co., 10 Arrow St., Cambridge, Mass.
Precision devices in industrial & scientific fields

Microchemical Service, 30 Van Zandt Ave., Douglaston, N. Y.
Microchemical laboratory apparatus

Micro Master Co., 919 W. North St., Chicago 22, Ill.
Dial indicators & taper gages

Microstat Corp., P. O. Box 126, Norwalk, Conn.
Photographic equipment for use in microfilming industry

Micro Switch Corp., Spring St., Freeport, Illinois
Snap action switches

Midwest Aircraft Products, Inc., 915 Valley Street, Dayton 4, O.
Solenoid valves

Mid-West Dynamometer & Engg. Co., Western Ave., at 60 St., Chicago, Ill.
Dynamometers

Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Radio test instruments

Miller Co., B. F., P. O. Box 455, Trenton, N. J.
Electrical testing devices

Miller Corp., Wm., 362 W. Colorado St., Pasadena, Calif.
Machine shop gages

Millers Falls Co., Greenfield, Mass.
Machine shop gages

Million Radio & Television, 685 West Ohio St., Chicago, Ill.
Radio & allied testing instruments

Milwaukee Gas Specialty Co., 2025 W. Clybourn, Milwaukee, Wis.
Valves, fittings & safety shut-offs for gas fired equipment

Minerallac Electric Co., 25 N. Peoria St., Chicago, Ill.
Potential detectors

Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa.
Instruments for the detection, analysis & recording of toxic and combustible gases; instruments for sampling, counting & measuring dust particles

Mine & Smelter Supply Co., 1422-17th St., Denver, Colo.
Industrial equipment & supplies

Minneapolis Elec. & Construction Co., 80 South 12th St., Minneapolis, Minn.
Wire length measuring machines

Minneapolis-Honeywell Reg. Co., 2727 - 4 Ave., S. Minneapolis, Minn.
Heating, ventilating and air conditioning control equipment; thermostats; safety controls; motor and diaphragm operated valves; relays; furnace controllers

Mobile Refrigeration, Inc., 630 Fifth Ave., New York, N. Y.
High altitude test & calibration chambers

Moeller Instrument Co., 132nd St. & 89th Ave., Richmond Hill, N. Y.
Thermometers, hydrometers, etc.

Moist-O-Meter, Inc., Board of Trade Bldg., Kansas City, Mo.
Moisture testers

Moisture Register Co., 5117 K'n'le, Los Angeles, Calif.
Moisture testing instruments & devices

Moline Furniture Works, Moline, Ill.
Laboratory furniture

Monarch Manufacturing Co., 20 N. Major Ave., Chicago 39, Ill
Radio set testers

Monarch Manufacturing Works, Inc., Salmon & Westmoreland Sts., Philadelphia, Pa.
Strainers, oil burner nozzles & regulating valves, viscosimeters

Monitor Controller Co., Gay, Lombard & Frederick Sts., Baltimore, Md.
Electrical controllers

Moore Products Co., 901 E. Lycoming St., Philadelphia 24, Pa.
Industrial instruments

Morehouse Machine Co., York, Penna.
Proving rings

Morey and Jones, Ltd., 922 So. Hemlock St., Los Angeles, Calif.
Recording & indicating flow meters

Morse Twist Drill & Machine Co., New Bedford, Mass
Gear testers

Mosher Electronic Control Systems, 130 W. 42 St., New York 18, N. Y.
Electronic bin level indicators & electronic load regulators for pulverizing machinery

Mott Smith Corp., 1505 Shell Bldg., Houston, Texas
Geophysical instruments

Munsell Color Co., Inc., 10 E. Franklin St., Baltimore, Md.
Color comparators

Mu-Switch Corp., Canton, Mass.
Snap action switches

Muter Company, 1255 S. Michigan Ave., Chicago, Ill.
Radio & electrical products

N

Nashville Surgical Supply Co., 401 Church St., Nashville, Tenn.

Nathan Mfg. Co., 250 Park Ave., New York, N. Y.
Valves

National Airoil Burner Co., 1284 E. Sedgley Ave., Philadelphia, Pa.
Liquid level controllers

National Aluminate Corp., 6216 West 66th St., Chicago, Ill.
Conductivity meters

National Brass Co., 1600 Madison St., S. E., Grand Rapids, Mich.
Combustion & draft controllers

National Carbon Co., Inc., Carbon Products Div., P. O. Box 6087, Cleveland 1, Ohio
Accelerated weathering testers

National Electric Controller Co., 5305 Ravenswood Ave., Chicago, Ill.
Rheostats

National Engineering Products, Inc., Commerce & Savings Bldg., Washington, D. C.
Pressure gage equalizers

National Instrument Co., 44 School St., Boston, Mass.
Electro-mechanical instruments & devices

National Meter Co., 4207 First Ave., Brooklyn, N. Y.
Water, oil & gasoline meters

National Research Corp., 100 Brookline Ave., Boston, Mass.
Optical products, high vacuum apparatus

National Scientific Corp., 2141 W. North Ave., Chicago, Ill
Laboratory supply house

National Technical Labs., 820 Mission St., Pasadena, Calif.
Beckman pH instruments and electro-metric pH equipment for completely automatic indication, control & recording of pH in large scale industrial processes

National Time & Signal Corp., 600 East Milwaukee Ave., Detroit, Mich.
Timers for welding & industrial process control

Natural Gas Equipment Inc., 541 Petroleum Securities Bldg., Los Angeles, Calif.
Furnace controllers

Naxon Utilities Corp., 2101-2111 West Walnut St., Chicago, Ill.
Instrument cleaning machines

Negus, T. S. & J. D., 69 Pearl St., New York, N. Y.
Nautical instruments

Nelson Section Liner Co., 229 W. Garden St., DeKalb, Ill.
Drawing instruments

Nelson Vacuum Pump Co., Geo. F., 2918 Fulton St., Berkeley, Calif.
High vacuum pumps

Neptune Meter Co., 50 W. 50th St., New York, N. Y
Liquid meters

Nester Company, Inc., L. G. Millville, N. J.
Oxygen regulators

Newark Scale Works, 10-12 Hobson St., Newark, N. J.
Scales

Newark Wire Cloth Co., 336 Verona Ave., Newark, N. J.

N. J. Laboratory Supply Co., 235 Plane St., Newark, N. J.
Laboratory supplies

New Jersey Meter Co., Plainfield, N. J.
Compressed air meters, separators for removing water & oil from compressed air lines, liquid flow indicators with low flow signalling circuit.

N. Y. Laboratory Supply Co., Inc., 530 Broadway, New York, N. Y.
Laboratory supplies

New York Scientific Supply Co., 111 East 22nd St., New York, N. Y.
Laboratory supplies

New York Transformer Co., 51 West 3 St., New-York, N. Y.
Sieves
Transformers

Niagara Electrical Instrument Co., 725 Genesee Bldg., Buffalo, N. Y.
Electrical power analyzer

Niehoff & Co., C. E., 4925 Lawrence Ave., Chicago, Ill.
Auto test equipment

Northern Engraving & Mfg. Co., La Crosse, Wis.
Aviation instruments, pressure gages

Northern Equipment Company, 1945 Grove Drive, Erie, Pa.
Boiler feed control

Northern Laboratories, Ltd., 50 Church St., New York 7, N. Y.
Custom built test chambers involving charges of temperature, pressure and humidity and specialized thermo-dynamic and electronic development.

Norton Co., Worcester, Mass.
Refractory laboratory wave, porous plates & tubes

Norton Electrical Instrument Co., 101 Hilliard St., Manchester, Conn.
Electrical instruments

Nothelfer Winding Laboratories, 109 Albemarle Ave., Trenton, N. J.
Transformers

Nurnberg Thermometer Co., Inc., 397 Bridge St., Brooklyn, N. Y.
Thermometers & Hydrometers

Nye, Inc., Wm. F., New Bedford, Mass.
Instrument & watch oils

O

Ohio Injector Co., 3 Main St., Wadsworth, Ohio
Check valves

Ohmer Fare Register Co., 740 Bolander Ave., Dayton, Ohio
Mileage recorders

Ohmite Mfg. Co., 4826 W. Flournoy St., Chicago, Ill.
Close control rheostats, fixed & adjustable power resistors, precision & non-inductive resistors, attenuators, tap switches and R. F. chokes.

Olsen Testing Machine Co., Tinius, 500 N. 12th St., Philadelphia, Pa.
Testing machines

Omega Machine Co., 3409 E. 18 St., Kansas City, Mo.
Chemical feeding equipment for dry or liquid materials, by volume or by weight

Optical Engineering Labs., 63 Park Row, New York, N. Y.

Orton Jr. Ceramic Foundation, Edward, 1445 Summit St., Columbus, Ohio
Seger cones

Oster Mfg. Co., John, Racine, Wis.
Fractional horsepower motors

P

Pacific Biological Labs., Pacific Grove, Calif.
Laboratory supplies

Pacific Scientific Co., Inc., Bendix Bldg., Los Angeles, Calif.
Cable tension indicator

Pacific Tool & Supply Co., 344 N. Vermont Ave., Los Angeles, Calif.
Inside micrometers, telescope gages

Palmer Co., 2511 Norwood Ave., Cincinnati, Norwood, Ohio
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Palo-Myers, Inc., 81 Reade St., New York, N. Y.
Laboratory supplies & boiler water testing equipment

Paprex Co., 24 Water St., Wakefield, Mass.
Paper plant test instruments

Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Timers

Park Sales Co., 421 Canal St., New York, N. Y.
Micrometers and calipers

Parks-Cramer Co., Fitchburg, Mass.
Humidity, heat & air change control, wet bulb temperature regulators

Paraloy Co., 600 S. Michigan Ave., Chicago, Ill.
Instrument bearings, pivots, relay mechanisms & parts.

Parr Instrument Co., 222 52nd St., Moline, Ill.
Combustion bombs, calorimeters, hydrogenation apparatus, melting point apparatus

Partlow Corp., 2 Campion Rd., New Hartford, N. Y.
Temperature indicators & controllers, time delay relays

Pastor Shop Watch Co., 43 East Main St., Waterbury, Conn.
Stop watches

Patterson Screen Co., Towanda, Pa.
X-Ray intensifying & fluoroscopic screens

Paulson & Co., Henry, 37 So. Wabash Ave., Chicago, Ill.
Watch checking instruments, horological & instrument tools & supplies

Paulstick & Sons, H., 2124 Fulton St., Brooklyn, N. Y.
Thermometers

Payne Furnace & Supply Co., Beverly Hills, Calif.
Domestic & commercial gas controls

Penberthy Injector Co., 1242 Holden St., Detroit, Mich.
Liquid level gages

Penn Electric Switch Co., Box 556, Goshen, Ind.
Automatic controls for pressure, temperature, humidity, liquid level; also mechanically actuated unit switches. Specialized controls for refrigeration, air conditioning, heating, pumps, air compressors.

Perfex Corp., 415 W. Oklahoma Place, Milwaukee, Wis.
Automatic temperature controls for oil burners, stokers, gas burners, refrigeration & air conditioning

Perkin-Elmer Corp., 535 Hope St., Glenbrook, Conn.
Optical instruments

Perkins & Son, Inc., B. F., Holyoke, Mass.
Testers for leather, paper & textiles

Permo Incorporated, 6415 Ravenswood Ave., Chicago, Ill.
Instrument pivots & contacts

Permutit Company, 330 West 42nd St., New York, N. Y.
Indicators & recorders for CO_2, specific gravity of natural, manufactured or process gases, exhaust gas analysis, other uses where gas density guides operation

Petrometer Corp., 42-26 28 St., Long Island City, N. Y.
Distant reading, liquid level tank gages

Pfaltz & Bauer, Inc., Empire State Bldg., New York, N. Y.
Laboratory control instruments

Philadelphia Thermometer Co., 915 Filbert St., Philadelphia, Pa.
Instruments for temperature indication, control & regulation

Phillips Manufacturing Co., 3475 W. Touhy Ave., Chicago, Ill.
Vapor degreasers & instrument cleaning machines

Phipps and Bird, Inc., Richmond, Va.
Laboratory apparatus & chemicals

Photobell Corp., 116 Nassau St., New York, N. Y.
Photoelectric equipment

Polarized Light-Photoelastic Co., 557 W. 124 St., New York 27, N. Y.
Photoelastic polariscopes

Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Industrial photoelectric controls including counting equipment, electronic timers & special electronic controls, smoke controls

Photovolt Corp., 95 Madison Ave., New York, N. Y.
Photo-electric elements, photometers, electronic timing devices, photo-electric colorimeters, photo-electric exposure meters, densitometers

Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
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Specialists in solution of unusual industrial research jobs, with special experience in machinery noise reduction, development of special instruments, & measurement of surface irregularities

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Governors

Pierce Watch Company, 22 West 48th St., New York, N. Y.
Stop watches

Pike & Co., E. W., Elizabeth, N. J.
Illuminated magnifiers & microscopes

Pioneer Instrument Division of Bendix Aviation Corp., Bendix, N. J.
Aircraft instruments

Pitometer Log Corp., 206 Lafayette St., New York, N. Y.
Pitot tube flowmeters

Pittsburgh Equitable Meter Co., 400 N. Lexington Ave., Pittsburgh, Pa.
Gas & liquid meters, gas pressure regulators & accessories

Pittsburgh Instrument & Machine Co., 1026 Reedsdale St., Pittsburgh, Pa.
Brinell Machines, alternating impact machines, surveying instruments

Pittsburgh Taximeter Co., Point Bldg., Pittsburgh, Pa.
Vehicle recorders

Pneumatic Scale Corp. Ltd., Norfolk Downs Station, Quincy, Mass.
Packaging scales

Pneumercator Co., Inc., 305 E. 46th St., New York, N. Y.
Level indicators

Pointloid Inc., 93 Mercer St., New York, N. Y.
Fabricators of plastics, sheets, rods & tubes

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Automotive service instruments

Powers Regulator Co., 2734 Greenview Ave., Chicago, Ill.
Controls for air conditioning, temperature & humidity; also water temperature controls, dial indicating & recording thermometers & steam traps

Practical Instrument Co., 2717 N. Ashland Ave., Chicago, Ill.
Recording thermometers & operation recorders

Pratt & Whitney, Div. Niles-Bement-Pond Co., Hartford, Conn.
Machine shop instruments

Precision Apparatus Corp., 92-27 Horace Harding Blvd., Elmhurst, L. I. N. Y.
Radio test instruments

Precision Gage & Tool Co., 320 East 3rd St., Dayton, Ohio
Machine shop gages

Precision Instrument Corp., 192-6 Central Ave., S. W., Atlanta, Ga.
Aviation instruments & microfilm cameras

Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Resistors

Precision Scientific Co., 1736 N. Springfield Ave., Chicago, Ill.
Standard & custom-built laboratory equipment

Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Scientific instruments

Precision Tube Company, 3824-26-28 Terrace St., Philadelphia, Pa.
Fine tubing & metal shielded wire

Preferred Utilities Mfg. Corp., 31 West 60th St., New York, N. Y.
Boiler plant instruments

Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
Piezo electric quartz and tourmaline crystals, reactance & capacity meters

Premier Metal Etching, 21-03 44th Ave., Long Island City, N. Y.
Instrument dials & scales; nameplates & panels

Process Controls, Inc., Le Roy, N. Y.
Paper industry controls

Production Instrument Co., 710 W. Jackson Blvd., Chicago, Ill.
Electric & mechanical counting, timing & recording devices & actuating switches

Pyle National Co., 1334 N. Kostner Ave., Chicago 51, Ill.
Connectors

Pyrometer Instrument Co., 103 Lafayette St., New York, N. Y.
Pyrometers for various purposes

R

Racine & Co., Jules, 20 West 47th St., New York, N. Y.
Stop watches

Radio City Products Inc., 88 Park Place, New York, N. Y.
Electrical & radio testing instruments & accessories

Radio Transceiver Labs., 8627 115th St., Richmond Hill, New York
High frequency radio transmitters & receivers

Rahm Instruments, Inc., 12 W. Broadway, New York, N. Y.
Direct reading oscillographs & strip chart recorders

Ranco, Inc., 601 West Fifth Ave., Columbus, Ohio
Refrigeration controls

Randall, Frank E., 248 Ash St., Waltham, Mass.
Machinists' dial gages

Rascher & Betzold, 829-835 Orleans St., Chicago, Ill.
Laboratory supplies

Rauland Corp., 4245 N. Knox Ave., Chicago, Ill.
Amplifiers, audio-frequency equipment, variable capacitors, photoelectric cells, microphones

Rawson Electrical Instrument Co., 110 Potter St., Cambridge, Mass.
Dynamometers, wattmeters, milliammeters & voltmeters. Also ultra-sensitive meters both for A.C. & D.C., fluxmeters, electrostatic voltmeters, Thermocouples in vacuum, earth current meters, cable testers, milli-second timers

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Automatic & manually controlled rectifiers for all communication, industrial or laboratory applications

R. C. A. Manufacturing Co., Inc., Camden, N. J.
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Read Machinery Co., Inc., York, Penna.
Chemical & Industrial Equipment

Leadrite Meter Works, Bluffton, Ohio
Electrical instruments

Redington Co., F. B., 112 S. Sangamon St., Chicago, Ill.
Counters: production, revolution, stroke

Reed Small Tool Works, 40 Dewey St., Worcester, Mass.
Machine shop micrometers

Refinery Supply Co., 621 East Fourth St., Tulsa, Okla.
Gas testing instruments & specialties for oil & gas industry; & laboratory supplies

Refrigerating Specialties Co., 728 So. Sacramento Blvd., Chicago, Ill.
Automatic valves & regulators

Rehtron Corp., 4313 Lincoln Ave., Chicago 18, Ill.
Photoelectric equipment

Reich Mfg. Co., J. R., 43 East Stroup Road, Dayton, Ohio
Test indicators

Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, Ohio
Steam specialties

Reliance Instrument Co., 715 N. Kedzie St., Chicago, Ill.
Electrical instruments

Remler Company, Ltd., 2101 Bryant St., San Francisco, Calif.
Radio & inter-communicating systems

Republic Flow Meters Co., 2249 Diversey Parkway, Chicago, Ill.
Remote reading flow meters, complete line of power plant & industrial instruments for the measurement of flow, level, pressure, draft, temperature & CO_2. Automatic boiler controls, regulators, valves and desuperheaters

Revco, Inc., Deerfield, Mich.
Sub zero test cabinets

Revere Company, P. O. Box 304, Wallingford, Conn.
Thermocouples for liquids, air, metal, hot gases, Thermocouple wire, harnesses and leads. Pitot tubes (shielded & unshielded). Engine & Flight test recording accessories

Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, L. I., N. Y.
Protected & unprotected slide-contact rheostats & adjustable, wire wound resistors

Reynolds Gas Regulator Co., Anderson, Ind.
Automatic valves & regulators

Rhamstine, J. Thos., 500 E. Woodbridge St., Detroit, Mich.
Photoelectric cell equipment

Rhodes, Inc., M. H., 30 Bartholomew Ave., Hartford, Conn.
Time switches

Richards, Arklay S., 52 Winchester St., Newton Highlands, Mass.
Thermocouples, lead wire & protection tubes

Richards Allen Corp., 15 W. 20 St., New York, N. Y
Timer & time switches

Richards Scale Co., Clifton, N. J.
Auto ic weighing machinery

Riehle T ting Machine Division, American Machine & Metal Inc., East Moline, Ill.
Testi machines & testing instruments for tension, comp sion, bending, torsion, shear, hardness, wear

Rieker trument Co., 1919 Fairmount Ave., Philadelph Pa.
Scien ic instruments

Ring-Ba nce Instrument Co., 740 N. Franklin St., Chica , Ill.
Flow eters, draft & pressure gages for low pressure s & air measurements. Recording, indi ating & in grating in any combination

Riverba Laboratories, Geneva, Ill.
Tunin forks

R & M Mfg. Co., Royal Oak, Mich.
Machine shop gages

Robertson & Co., John H., 1767 W. Armitage Ave., Chicago, Ill.

Robertson, 3rd, J. L., 116 Broad St., New York, N. Y.
Engine indicator accessories

Robertshaw Thermostat Co., Youngwood, Pa.
Thermostats

Robinson Optical Co., 3048 Rodman St., N. W., Washington, D. C.
Optical flats, mirrors, prisms & lenses

Robinson Orifice Fitting Co., 1435 Santa Fe Ave., Los Angeles, Calif.
Orifice fittings & plates

Rochester Mfg. Co., Inc., Rochester, N. Y.
Pressure & liquid level indicators & thermometers

Rockwell Co., Stanley P., 296 Homestead Ave., Hartford, Conn.
Dilatometers

Rogear Co., 11 Water St., New York, N. Y.
Paints which change color with temperature.

Roemer Drug Co., 606 N. Broadway, Milwaukee, Wis.
Laboratory supply house

Reller-Smith Co., Bethlehem, Pa.
Instruments (indicating & graphic), air & oil circuit breakers, relays, switchboards, precision balances, transformers, instrument & control switches

Rolnick Testing & Mfg. Co., 316 N. 22 St., Philadelphia, Pa.

Roth Brothers Chronometer Co., 104 E. 23 St., New York, N. Y.
Marine chronometers, sextants, torpedo boat watches

Rowe Radio Research Laboratory Co., 2422 N. Pulaski Road, Chicago 39, Ill.
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Precision electrical instruments: potentiometers, galvanometers, bridges, resistance standards, for standardization, research, calibration of meters, production testing, & educational applications. Photoelectric colorimeters, transmission dynamometers & other special apparatus

Rueckert Manufacturing Co., 69 Sprague St., Providence, R. I.
Cases for instruments

Ruehfel Co., Inc., George, 93-08 95 Ave., Ozone Park, N. Y.
Laboratory instruments & apparatus

Rupp & Bowman Co., 315 Superior St., Toledo, Ohio
Laboratory supplies

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Betts & Betts Corporation	115, 116
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Bodine Electric Company	64
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Boulin Instrument Corporation	99
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Burlington Instrument Company	12
Cambridge Instrument Co., Inc.	10, 50, 51, 53, 55, 62, 64, 72, 76, 130
Cargille, R. P.	54
Carson Micrometer Corp.	61
Certified Gauge & Instrument Corp.	43
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Clarostat Mfg. Company	90
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Cochrane Corporation	37
Cole Instrument Company	10, 58, 96
Columbia Metal Box Company	18
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Connelly Iron Sponge & Governor Co.	45
Consolidated Engineering Corp.	68, 122
Continental Electric Company	120
Cornell-Dubilier Electric Corp.	19
Cramer Company, Inc., The R. W.	116
Daven Company, The	Inside back cover
Du Mont Laboratories, Inc., Allen B.	69
Durant Manufacturing Company	33
Eby, Inc., Hugh H.	22
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Electro-Medical Laboratory, Inc.	22, 66
Electronic Products Company	12
Elematic Equipment Corporation	77
Engelhard, Inc., Charles	51
Eppley Laboratory, Inc.	Inside front cover, 20
Ess Instrument Company	24
Executone, Inc.	13
Faichney Instrument Corp.	109
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Fenwal Incorporated	114
Fish-Schurman Corporation	26, 52
Fleischhauer & Son, Fr.	108
Fox Munitions Corporation	45
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Gallien, R. P.	54
Geier & Bluhm, Inc.	55
General Controls	121
Geophysical Instrument Company	51
Glendale Optical Company	74
Gorrell & Gorrell	132
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Guardian Electric	87
Hagedorn Engineering Company	40
Hanlon-Waters, Inc.	31
Hart Moisture Gauges, Inc.	102
Hathaway Instrument Company	66
Hays Corporation, The	24, 29, 42, 50
H-B Electric Company, Inc.	84
Heiland Research Corporation	68, 122
Heise Bourdon Tube Laboratories	46
Herkimer Tool & Model Works	42
Hewlett-Packard Company	125
H & H Thermostats, Inc.	10, 113
Hickok Electrical Instrument Co.	12, 40, 126
Holtzer-Cabot Electric Co., The	65
Hopp Press, Inc., The	35
Illinois Testing Laboratories, Inc.	77
Indicating Calipers Corp.	18
Industrial Filter & Pump Mfg. Co.	103
Industrial Instruments, Inc.	4
Jarrell-Ash Company	94
J-B-L Instrument Company	96
J-B-T Instruments, Inc.	13, 41, 77
Jones-Motrola Sales Company	94
King Engineering Corporation	46
Kollsman Instrument Company	10
Kron Company, The	92
Kurman Electric Co., Inc.	85
Laboratory Specialties, Inc.	76
Leeds & Northrup Company	Outside front cover, 17, 29, 52, 75, 79, 97
Leupold and Stevens Instruments	38
Lewis Engineering Company, The	Back cover
Lindberg Engineering Company	31
Liquidometer Corporation	44
L & R Manufacturing Company	8
Manning, Maxwell & Moore, Inc.	84, 108, 112
Marsh Corporation, Jas. P.	48, 110
Mason-Neilan Regulator Co.	27
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Merkle-Korff Gear Company	62
Minneapolis-Honeywell Regulator Co.	28, 39, 50, 75, 79, 107
Mobile Refrigeration Div.	21
Moeller Instrument Company	111
Moisture Register Company	60
Morey & Jones, Limited	39
National Research Corporation	121
National Technical Laboratories	91
New Jersey Meter Company	38
New York Transformer Company	118
Northern Laboratories, Ltd.	22
Ohmite Manufacturing Company	89
Oster Mfg. Company of Illinois, John	62
Palmer Company, The	108
Palo-Myers, Inc.	136
Paraloy Company, The	
Parr Instrument Company	
Paulson & Company, Henry	
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Warrick, Charles F.	2
Weklser Thermometer Corporation	11
Welch Scientific Company, W. M.	1
Weston Electrical Instrument Corp.	11, 53, 97, 102, 10[illegible], 12
Wheelco Instruments Co.	29, [illegible]3, 7
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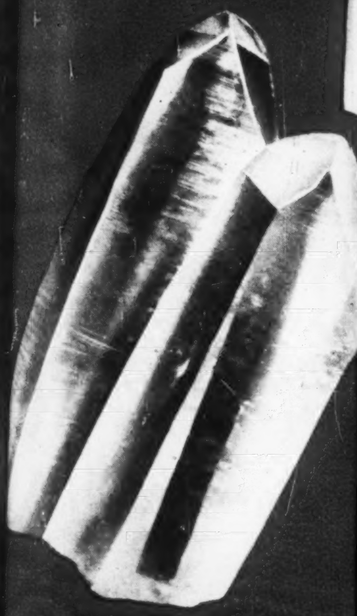

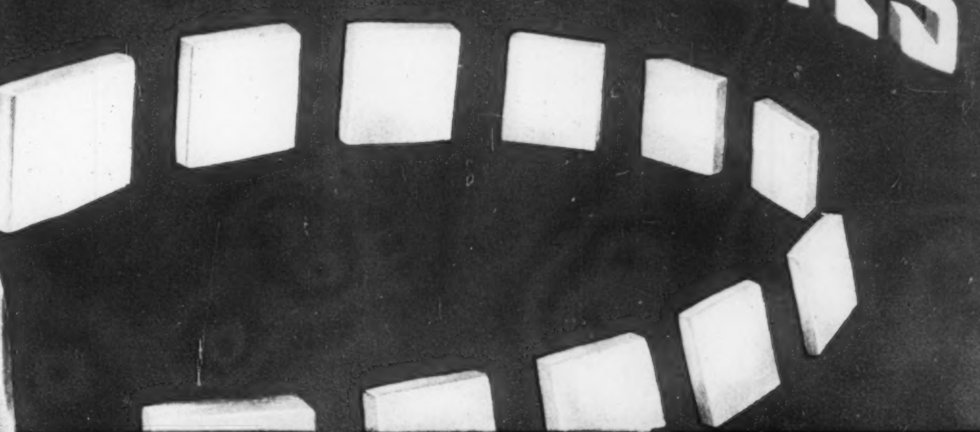

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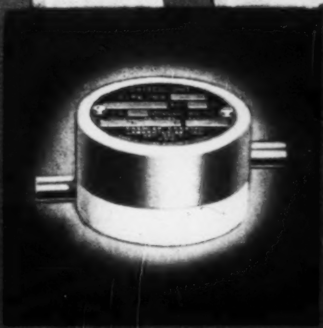

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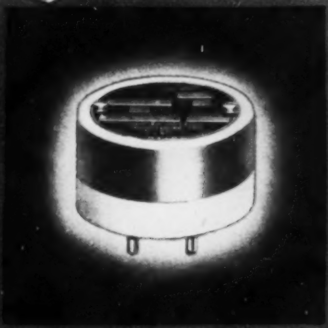

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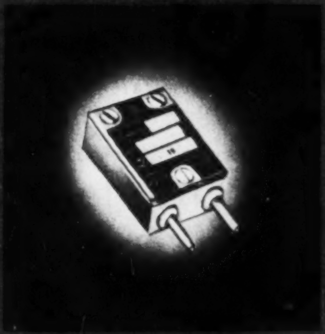

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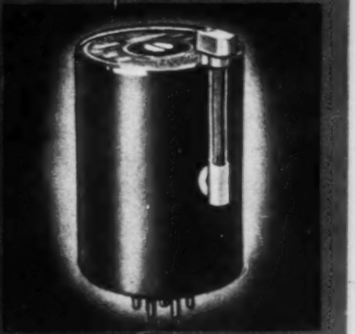

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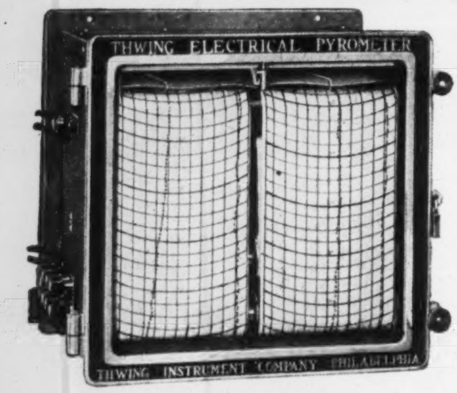
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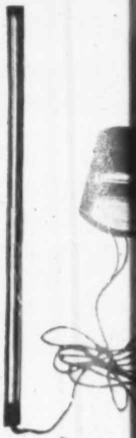

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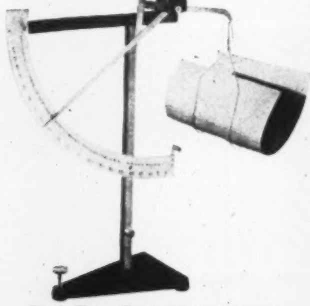

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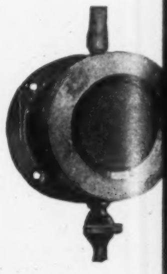

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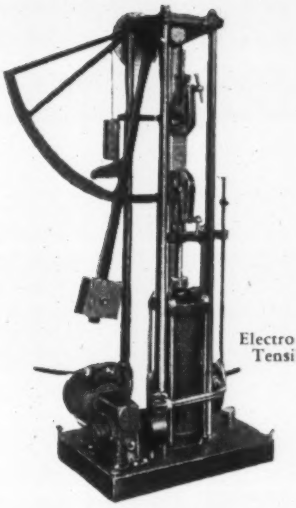

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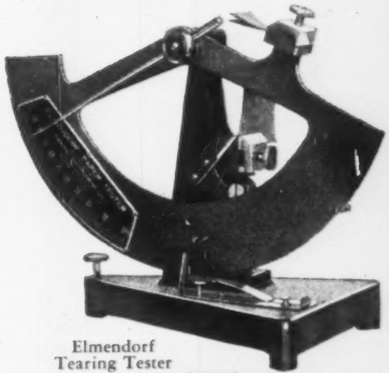

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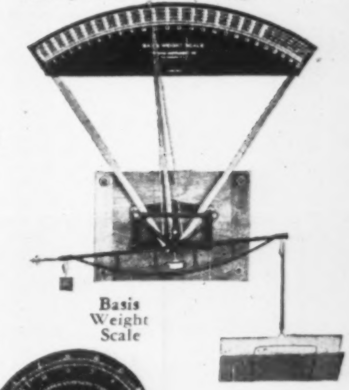

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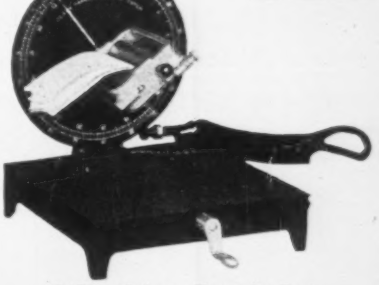

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6

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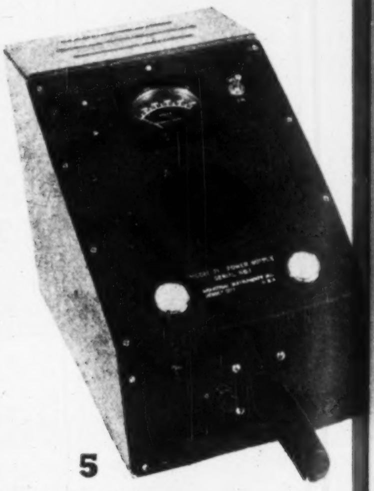

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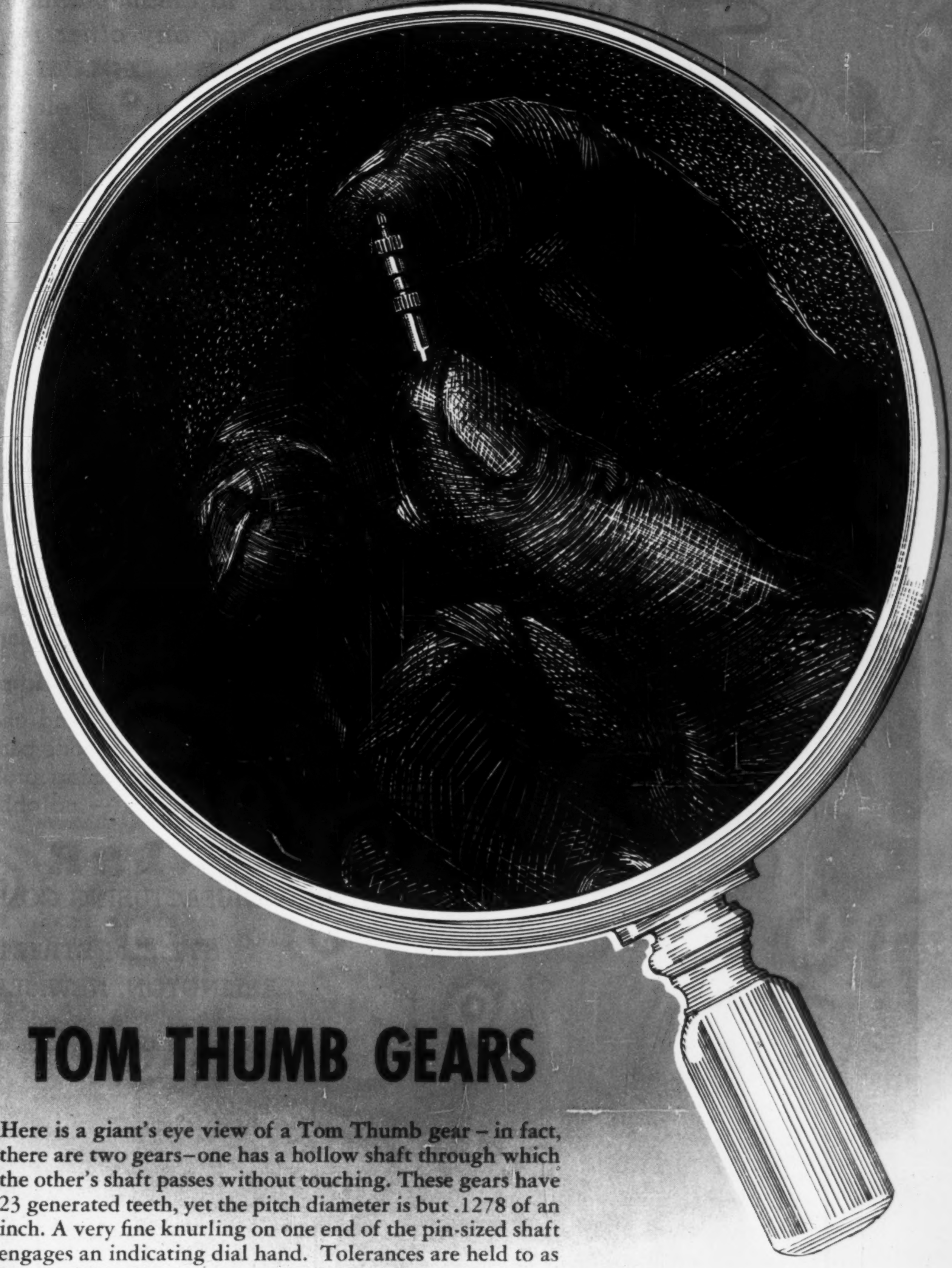

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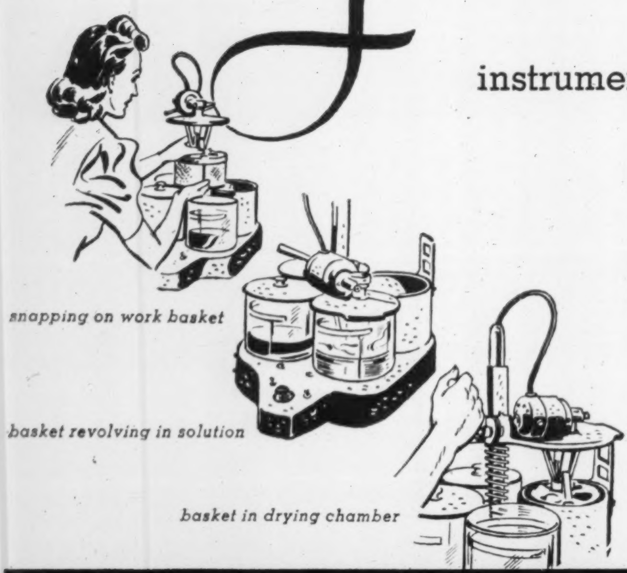
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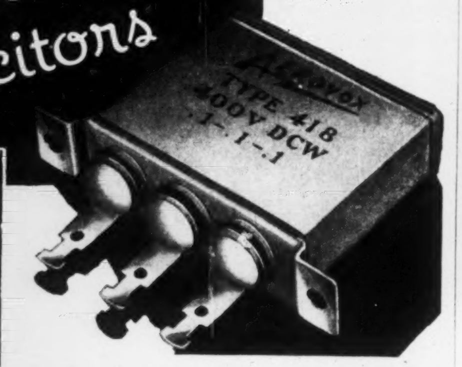

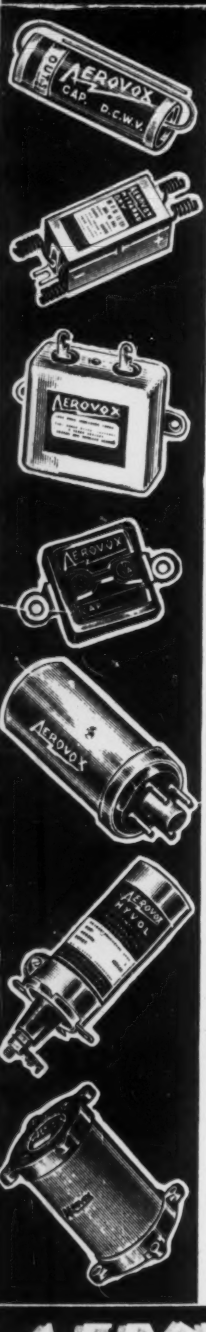

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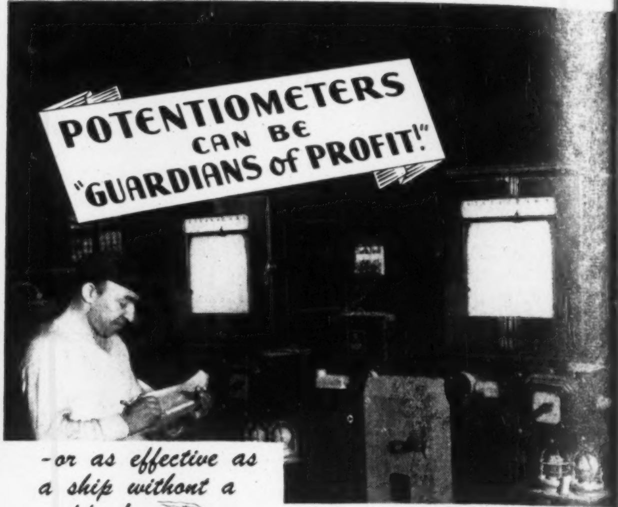

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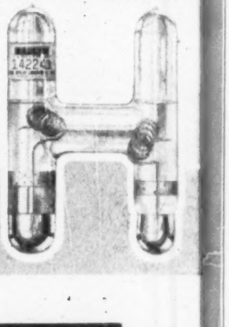

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Weston Elec. Inst. Corp.
Worner Products

CELLS, Standard
Cambridge Inst. Co.
Eppley Lab.
Leeds & Northrup Co.
Rubicon Co
Tagliabue Mfg. Co.
Thwing-Albert
Weston Elec. Inst. Corp

CEMENT APPARATUS (See Testers & Testing Machines, Cement)

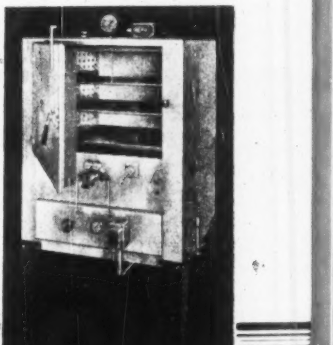
CEMENTING GAGES (See Gages, Cementing)

CEMENT MOLDS
Central Scientific Co.
Fisher Scientific Co.
Humboldt Mfg. Co.
Precision Scientific Co.
Standard Concrete App.

CEMENT NEEDLE APPARATUS
Fisher Scientific Co.
Humboldt Mfg. Co.

CENTRIFUGES
Clay-Adams Co.
Fisher Scientific Co.
International Equipment
Precision Scientific Co.
Sargent & Co.
Technical Products Co.
Williams Apparatus Co.

CENTRIFUGES, Paper Testing
Williams Apparatus Co.



TEMPERATURE CONTROL CABINETS

FOR baking, drying, heat treating, conditioning, accelerated aging, and scores of other laboratory uses, "Precision" - Freas constant temperature cabinets offer an extensive variety of models to choose from. Illustrated here is a steam-heated cabinet approved by Underwriters for hazardous locations. If a *standard* model won't handle your job we can build a *special* cabinet that will.

Write for Bulletin

PRECISION SCIENTIFIC COMPANY
1750 N. SPRINGFIELD, CHICAGO

ALTITUDE, HUMIDITY and REFRIGERATION

To Specifications

HIGH ALTITUDE CALIBRATION CHAMBERS

Temperature: –100°F to +190°F with automatic control.

Vacuum: to .5 Hg. Ab.

Size: 12"x12" to any capacity desired

Humidity: 20° RH to 95° RH with automatic control from 0°F to 190°F

COLD CHAMBERS

Specifications identical to Altitude Chambers except that no vacuum is provided.

FLIGHT CHAMBERS

Temperature: to –100°F

Vacuum: to 80,000 ft. with automatic control of temperature compared to pressure.

Humidity: Manual or automatic control from 20°RH to 95°RH

CONSTRUCTION

Cold Wall Construction.

Multi stage refrigeration.

Full vision doors.

Finger tip control to ±2°F.

ACCESSORY EQUIPMENT

Special recording temperature controllers.

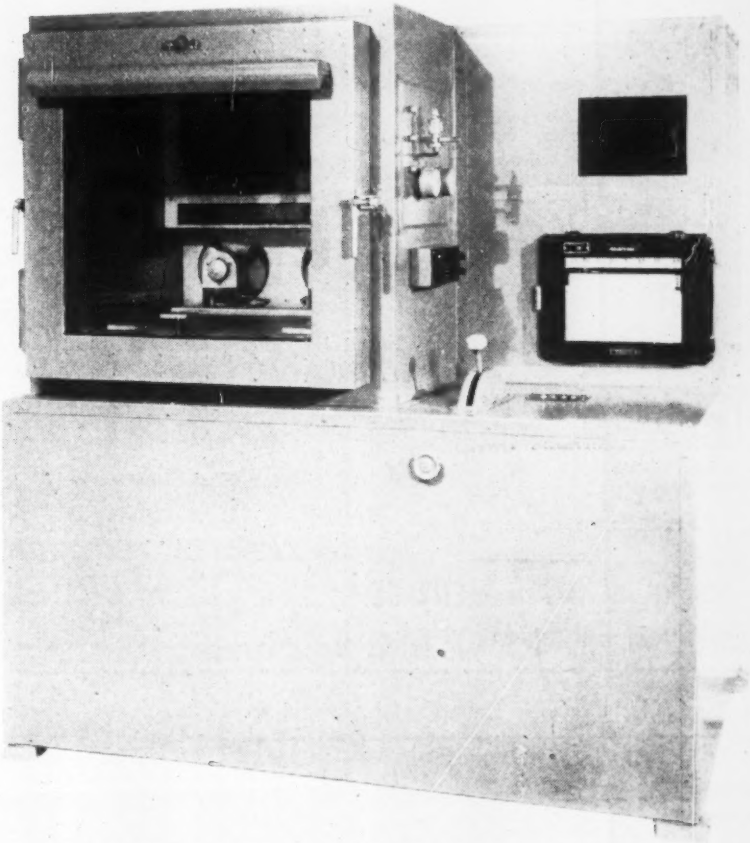
Special recording temperature indicators

Manometers and altimeters.

Vertical speed indicators.

Special recording humidity controllers.

Special recording vacuum instruments.

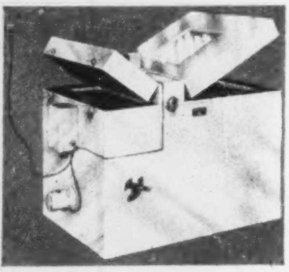


Test and calibration chambers serve such diversified needs that many of the requirements of equipment manufacturers can be met only by specially designed units. Within the scope indicated, we can build equipment to your individual specifications. All units incorporate positive automatic mechanical means of refrigeration and control, plus an indicating recording controller where specified. All sizes of chambers mentioned refer to clear inside test space.

BOWSER, INC.
MOBILE REFRIGERATION DIVISION
155 EAST 44th STREET
NEW YORK 17, N. Y.

FOR LOW-TEMPERATURE TESTING AND STORAGE
Minus 100° to Plus 220°F.
Constancy: ± ½°F.

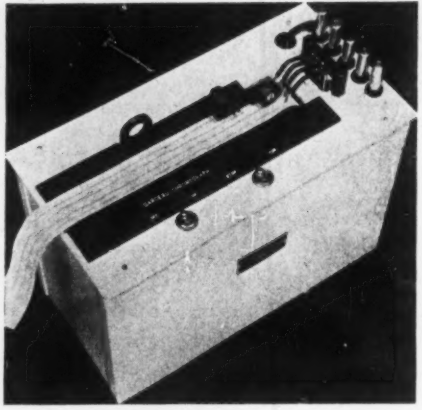
AMINCO **Constant Temperature**
SUB-ZERO CABINET
Dry Ice Cooled



A reliable, convenient, and speedy means of testing instruments, aircraft equipment and many materials to determine their performance, durability, etc. at sub-zero temperatures.

Write for Bulletin D-2120

AMERICAN INSTRUMENT CO.
Silver Spring, Maryland



GARCEAU CHRONOGRAPH

Inkless Recording with Inertialess Marking System

Models available with speed ranges from 1 cm. per hour to 100 cm. per second and with up to 25 traces. Supplied with plain or printed charts.

•

ELECTRO-MEDICAL LABORATORY, INC.
HOLLISTON, MASSACHUSETTS, U.S.A.
Makers of the Electroencephalograph

Post War Clock Movements
by
CHELSEA

Our production of special clock movements and clockwork mechanisms for recording instruments must wait until this war is won. Meanwhile we would welcome the opportunity of working with you in developing your post-war designs.

Remember, Chelsea has been making special movements for recording instruments for many years.

ARMY E NAVY

Let's continue to back the attack!

CHELSEA CLOCK COMPANY
385 EVERETT AVE., CHELSEA 50, MASS.

TEST CHAMBERS
- **HIGH ALTITUDE**
- **LOW TEMPERATURE**
- **HUMIDITY**

Let us have your requirements. We can supply chambers of any size with temperatures to −80°C, vacuum to 29.5"Hg and full automatic humidity control.

PRESSURE HEAT COLD HUMIDITY

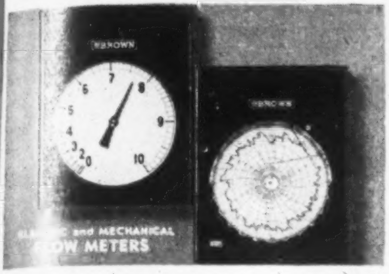
NORTHERN LABORATORIES LIMITED
50 CHURCH ST., N. Y. 7, N. Y.
FORMERLY NORTHERN ENGINEERING LABS.

EBY WORKS IN METALS AND PLASTICS FOR THE ELECTRICAL, COMMUNICATIONS, AND AVIATION INDUSTRIES

In one well knit organization Eby offers:
1. **Plastic Molding**
2. **Metal Stamping**
3. **Screw machine work**
4. **Tool and die department**
5. **Complete assembly**
6. **Packing, shipping (full or split), and storing**

Eby standard products are only a part of an experienced, competent engineering and production service which is equipped to handle special work in any quantities. Eby is set up to fit into your picture. Send us your problem and we'll work it out with you.

HUGH H. EBY INCORPORATED
18 W. CHELTEN AVE
PHILA. 44, PENNA.



For Controlling, Recording, Totalizing and Indicating the Flow of Fluids such as Steam, Water, Gas, Oil, etc.

Brown Flow Meters are available in two types, the Electric type and Mechanical type.

ELECTRIC TYPE: Complete equipment consists of three units, the orifice plate, manometer and instrument. Instrument can be located at a remote point from the orifice and manometer (point of flow measurement).

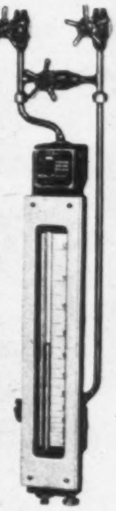
Because of this flexibility, it is particularly adaptable for applications where instruments are to be remotely located. Write for Catalog.

MECHANICAL TYPE: Complete equipment consists of two units, the orifice plate and the instrument. The meter body is integral with the instrument. Readings are transmited mechanically from meter body to instrument. Write for Catalog.

THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4482 Wayne Avenue, Philadelphia, Pa.

BROWN FLOW METERS
AND
MINNEAPOLIS-HONEYWELL CONTROL SYSTEMS
To Measure and Control is to Economize

FLOW METERS



● The Type H illustrated is an extremely accurate indicating instrument for measuring the flows of gases or liquids when operating pressures do not exceed 250 lbs. per sq. in. and the differential pressure does not exceed 160 inches of water pressure. Wall or Panel Mounting. Direct reading scales to meet any requirement. Also Inclined Tube types—for low differential ranges of 25" or 49" of water. Fully descriptive catalog sent on request.

THE MERIAM CO.
CLEVELAND, OHIO

Manometers, Meters, and Gauges for the accurate measurement of Pressures, Vacuums and Flows of Liquids and Gases.

30
35
40
25
GALLONS PER MINUT
45
20
15
10
50
MOREY & JONES, LTD.

SMALL *and* RUGGED—*yet* SENSITIVE *and* ACCURATE!

The MJL No. 163

RATE OF FLOW INDICATOR

(Differential Type)

EASILY READ

★

EASILY INSTALLED

★

REQUIRES LITTLE SPACE

3¼" in diameter
4" long

★

HANDLES HIGH PRESSURES

Can be furnished for use with line pressures up to 1,000 lbs. psi.

★

WILL WITHSTAND EXTREME OVER RANGING

Unique rupture-proof Bellows Unit takes the place of the mercury column commonly used in instruments of this type.

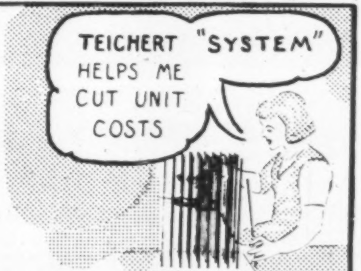
Write for Illustrated Bulletin No. 163-1

MOREY & JONES, LTD.
Industrial Instruments
922 South Hemlock St.
LOS ANGELES 21 CALIFORNIA

USE THE TEICHERT SYSTEM

BREAKAGE AGAIN! -- CAUSED BY OLD-FASHIONED METHODS

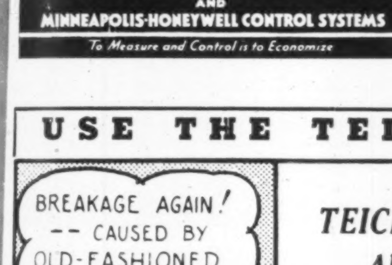
TEICHERT AIR-EXHAUSTION SYSTEM

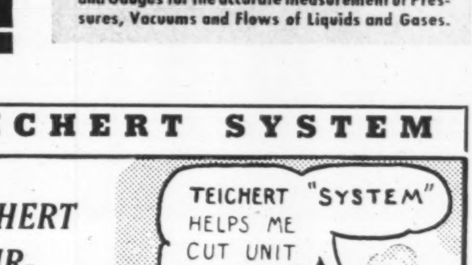

TEICHERT "SYSTEM" HELPS ME CUT UNIT COSTS

enables one girl to exhaust air and moisture out of 600 to 1000 chemical thermometers a day . . .

We can tell you if it will do your particular work.

BETTER GLASS-MAKING EQUIPMENT *from a single unit . . . to an entire plant*

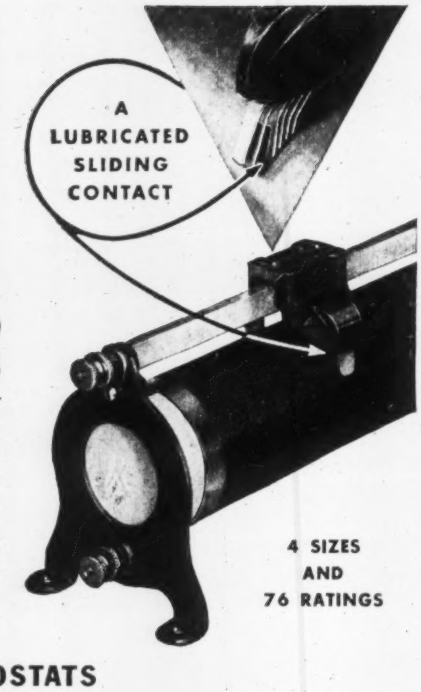




TEICHERT ENGINEERING CO.
80 UNIVERSITY PLACE
NEW YORK CITY 3

"FRAHM" VIBRATING REED FREQUENCY METERS

For dependable indication of power frequencies. Unaffected by wave form or by ordinary voltage and temperature changes. No pivots, jewels or rotating parts. Available in switchboard miniature and wide-range portable types. Various ranges between 15 and 500 cycles per second. Write for Bulletin 1695-I.



JAGABI "LUBRI-TACT" RHEOSTATS

For precise manual control of electric current. The "Lubri-tact" feature is a lubricated sliding contact, giving smooth adjustment and long life. A full range of instruments in a variety of types is usually carried in stock. Also compression type carbon Rheostats for smooth control of heavy currents. Write for Bulletin 1620-I.

James G. Biddle Co.

1211-13 ARCH STREET *Electrical and Scientific Instruments* PHILADELPHIA, PA.

HIGHEST

HICKOK

ACCURACY

Frequency Meters

Available in 4" rectangular panel mountin case—other sizes up to 6" case—entirely sel contained—*no external reactor* . . . Overal accuracy is better than .2 of a cycle in 6 cycles . . . Made with 55 to 65 cycle readin but also available in 59-61 cycle for greate reading accuracy and other ranges of frequenc . . . Indication by pointer and graduated scale easy to read . . . Vibration-proof and shock proof . . . Damping can be adjusted to sui extreme conditions of frequency variation . . Accurate within ambient temperature rang from minus 10 to plus 40 degrees C . . . Powe consumption only 0.8 watts at 115 volts.

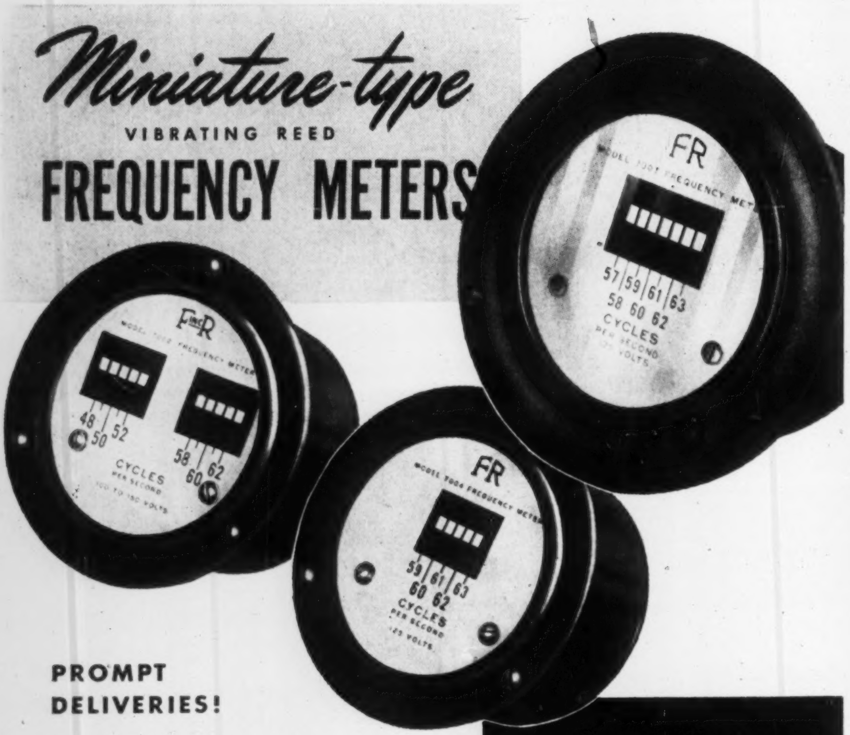
Write for illustrated booklet

HICKOK

ELECTRICAL INSTRUMENT COMPANY

10514 DUPONT AVE., CLEVELAND, OHI

Miniature-type VIBRATING REED FREQUENCY METERS



PROMPT DELIVERIES!

Three stock models—5, 7 and 10 reed...available in wide range of frequencies and all standard line voltages; operates correctly in any position. No pivots, jewels, or rotating parts . . . simple construction assures exceptional accuracy. Built to highest Government standards.

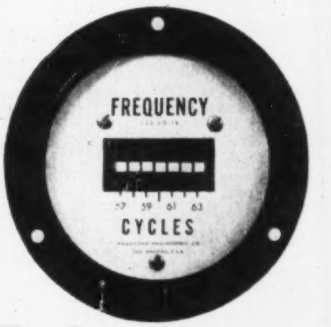
WIRSHING MANUFACTURING COMPANY
3234 Mines Avenue • Los Angeles 23, California

Write for complete catalog data and Quantity Prices, and learn the exceptionally favorable delivery available

---

New Improved *Vibrating Reed* FREQUENCY METER

57-63 Cycle Range



5 Advantages

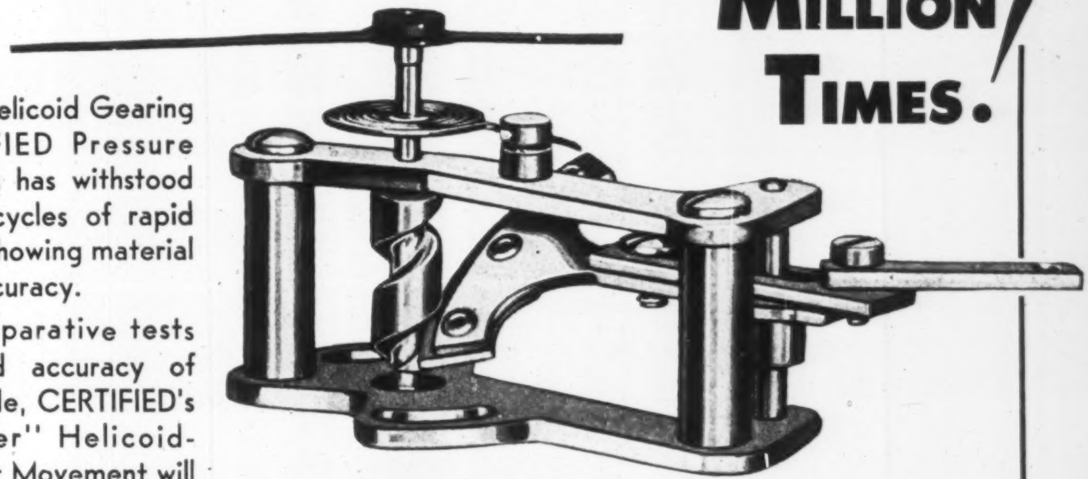
1. Reeds—Made of specially heat-treated durable, aged material. Wide reeds provide exceptional visibility.
2. Reed-assembly—Made in one unit with heavy reed base. No screwed-on parts.
3. Magnet—Alnico magnet provides permanency of calibration.
4. Coil—Substantial coil of heavy wire.
5. Construction—Simple and foolproof.—few parts—extremely stable.

Produced in a modern factory by most improved methods

Write for further information and prices.

HAGEDORN ENGINEERING CO.
8162 Beverly Blvd. Los Angeles, Calif.

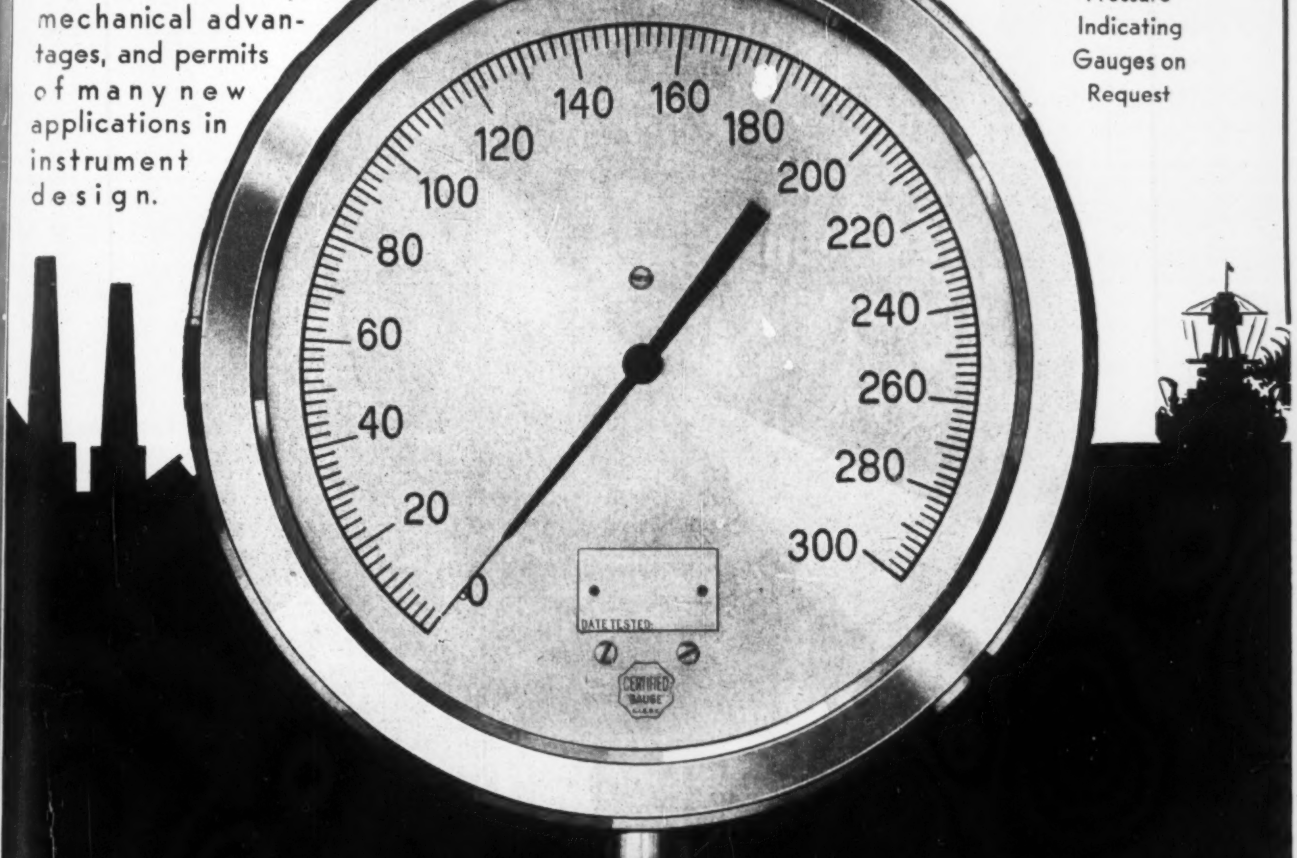
THE WORM THAT TURNED 30 MILLION TIMES!



The patented Helicoid Gearing used in CERTIFIED Pressure Indicating Gauges has withstood over 30,000,000 cycles of rapid pulsation without showing material wear or loss of accuracy.

Wherever comparative tests of durability and accuracy of indication are made, CERTIFIED's "Cam and Roller" Helicoid-Geared Instrument Movement will outperform all others.

Its flexibility of calibration results from unique mechanical advantages, and permits of many new applications in instrument design.



Catalog of Pressure Indicating Gauges on Request

CERTIFIED GAUGE & INSTRUMENT CORP.

34-18 Northern Boulevard . . . Long Island City 1, N. Y.

FEDERAL *Taperlock* GAGE HANDLES

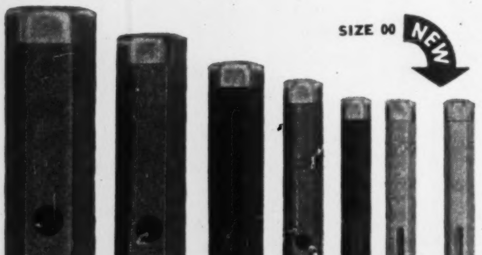
MADE of light weight plastic material, Federal Gage Handles are lighter than any metal used, even one-third lighter than aluminum. This lightness permits a most sensitive "touch" with less fatigue in long continued use; an advantage appreciated by women inspectors.

They are highly satisfactory with glass gages being so much lighter than metal handles, they reduce the danger of chipping and breakage.

Insulating properties help prevent transmission of bodily heat to gages which may affect accuracy.

Marking for identification is accomplished with the same marking tools used for metal gages.

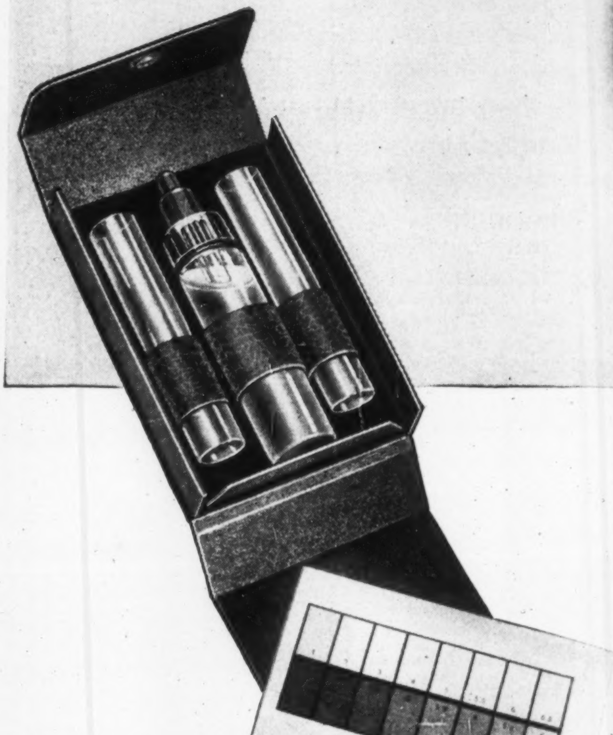
Immediate Shipments



FEDERAL TOOL CORPORATION
408 NORTH LEAVITT ST., CHICAGO, ILL.

New.

HANDY pH TEST KIT HAS MANY USES

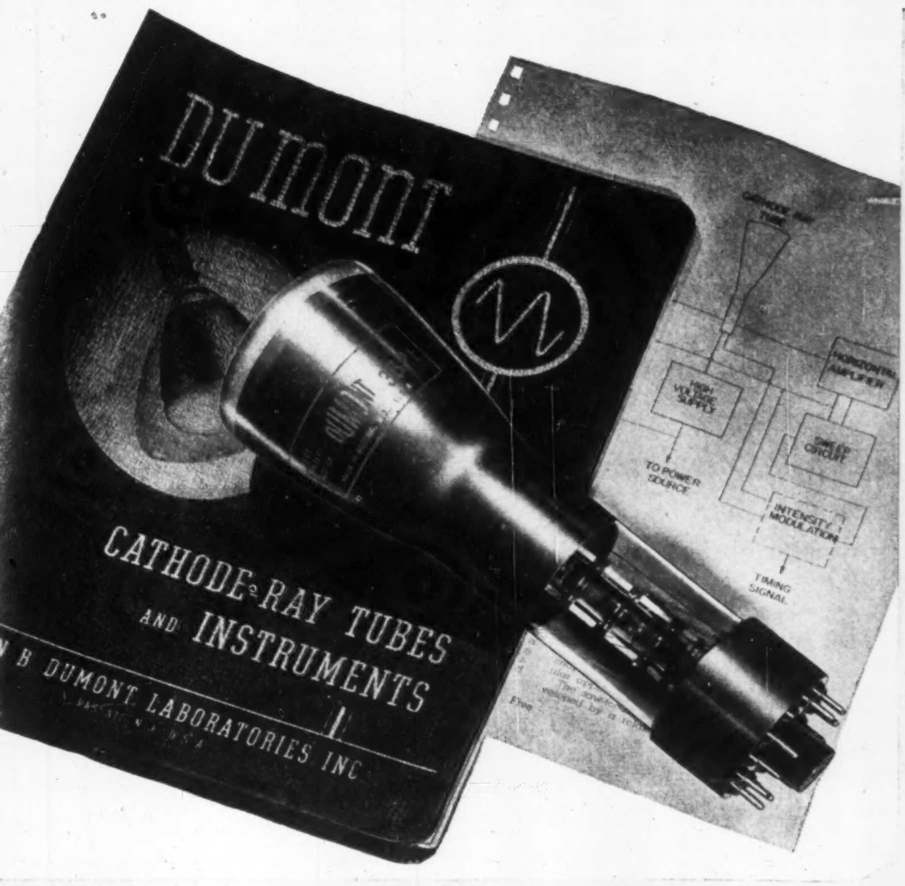


THIS HANDY Connelly pH test kit . . . small enough to be carried in a pocket . . . contains all necessary equipment for "on the spot" pH tests.

Simple, easy to use, just the thing where quick and reasonably accurate pH tests are required. Directions are with each kit . . . no previous experience necessary to make tests. No fuss — no muss — no bother. Always ready to use.

Write today

CONNELLY IRON SPONGE & GOVERNOR CO.
CHICAGO, ILLINOIS ELIZABETH, N. J.



CONTENTS OF MANUAL

The Cathode-Ray Oscillograph: introduction, general description, high-voltage power supply, amplifiers, linear time-base generator, intensity modulation, low-voltage power supply, mechanical considerations, conclusion.

• • •

Oscillograph Design Considerations: power supplies, amplifier design, time-bases or sweep generators.

• • •

DuMont Cathode-Ray Equipment: description, specifications, accessories, oscillograph type comparison list, specialty products.

• • •

DuMont Cathode-Ray Tube: general information, installation notes, type specification sheets, tube type comparison list.

• • •

Sales and Service Information: how to order, patent notice, price list, etc.

• • •

Instrument and Tube Application Notes: frequency and phase determination, photographic measurements, observation of relay rebounce, etc.

Cathode-Ray Tubes

. . . and how they are applied

For a dozen years past the Allen . DuMont Laboratories have spe- alized in the development, pro- uction and application of cathode- y tubes.

DuMont was the first to introduce e *commercialized* cathode-ray be as a practical tool for research orker, production engineer and chnician. Not only have DuMont bes and oscillographs resulted in vings in time required to investigate the many problems to which they are applicable, but they have also revealed truths in man's laws of the working forces of nature.

And now, as a further service, DuMont engineers have compiled a manual of pertinent data, together with detailed descriptions of DuMont tubes and associated equipment. This data is in loose-leaf form. The binder permits constant revision to keep pace with the fast-moving cathode-ray technique. Each manual bears a serial number so that the name and address of its recipient may be duly registered. Additional pages are mailed from time to time.

• • •

Write on your business stationery for your copy. Our Engineering Department is interested in aiding you with your cathode-ray application problems.

DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: WESPEXLIN, NEW YORK

8 BASIC ADVANTAGES OF F. & P. ROTAMETERS

1. Metering elements and fluid being metered clearly visible

2. Wide flow range — 20-to-1 easily obtained

3. Evenly spaced scale divisions — no compression of scale at low flows

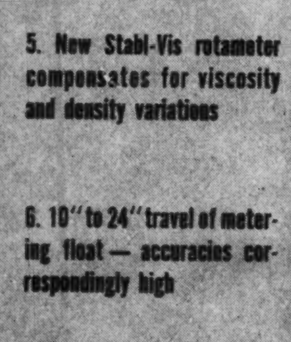
4. Low, constant pressure drop — reduces pumping costs

5. New Stabl-Vis rotameter compensates for viscosity and density variations

6. 10" to 24" travel of metering float — accuracies correspondingly high

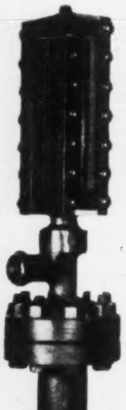
7. Instantaneous response to flow change — no friction or hysterisis

8. Measures corrosive gases, liquids and slurries that no other meter will handle accurately



A new Era in flow rate measurem !

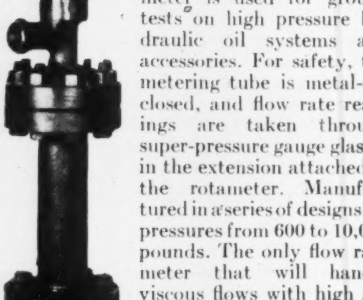
Rotameters for the AVIATION INDUSTRY



"Stabl-Vis" Armored ROTAMETER

— for high pressure flow rate metering

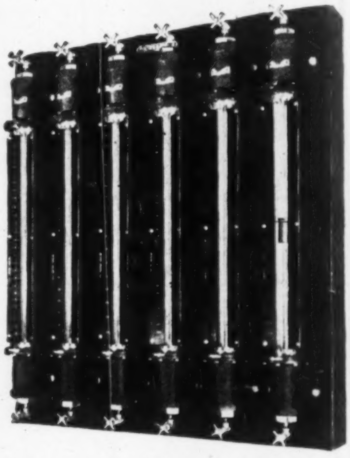
This armored Stabl-Vis rotameter is used for ground tests on high pressure hydraulic oil systems and accessories. For safety, the metering tube is metal-enclosed, and flow rate readings are taken through super-pressure gauge glasses in the extension attached to the rotameter. Manufactured in a series of designs for pressures from 600 to 10,000 pounds. The only flow rate meter that will handle viscous flows with high accuracy. Write for bulletin 43-D.



DE-ICER FLUID ROTAMETERS

for aircraft installation

These rotameters for de-icer fluid flow in two- and four-engine planes have individual floats which indicate visually the amount of fluid flow to each propeller or carburetor. They also have built-in needle valves for accurate control of the amount of flow. These meters conserve de-icer fluid and relieve the pilot's tension during the anxious moments when ice starts to form. The two-engine meter weighs 11 ounces; the four-engine meter (illustrated above) 1 lb. 14 ounces. Send for catalog 63-G showing complete installation diagrams.

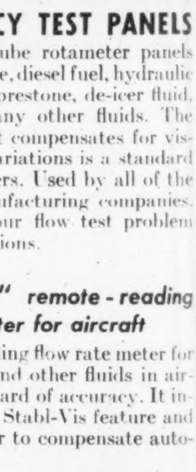


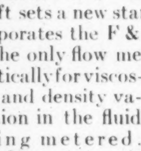
HIGH ACCURACY TEST PANELS

Single or multiple tube rotameter panels for measuring gasoline, diesel fuel, hydraulic oils, lubricating oils, prestone, de-icer fluid, oxygen, air, and many other fluids. The Stabl-Vis design that compensates for viscosity and density variations is a standard feature of these meters. Used by all of the major aviation manufacturing companies. Submit details of your flow test problem for our recommendations.

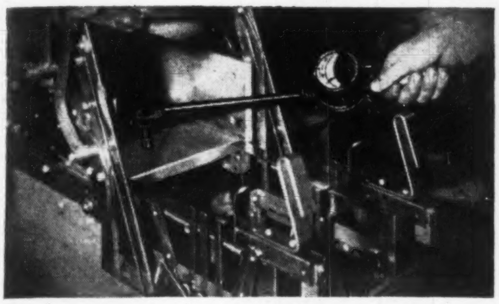
"MAGNA-BOND" *remote-reading flow rate meter for aircraft*

This new remote-reading flow rate meter for gasoline, "lube" oil and other fluids in aircraft sets a new standard of accuracy. It incorporates the F & P Stabl-Vis feature and is the only flow meter to compensate automatically for viscosity and density variation in the fluid being metered. Single engine unit (illustrated) complete weighs only $4\frac{1}{2}$ lbs. Dual unit for twin engines weighs $8\frac{1}{4}$ lbs. Write for catalog 63-G containing complete details.





FISCHER & P



Alnor PYROCON

...the contact pyrometer for quick accurate surface temperatures . . .

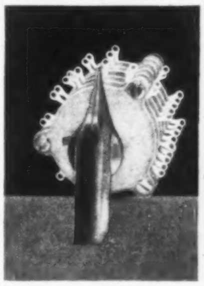
This convenient, all-purpose surface temperature pyrometer is ideally suited to a variety of industrial plant needs. Accurate temperature readings are obtained in a few seconds of plastic materials, liquids, oils, and similar materials, and of flat or curved, stationary or moving surfaces.

The Pyrocon shock-resisting movement is used with any one of eleven types of thermocouples, interchangeable without adjustment or re-calibration. Choice of rigid or flexible arms, or both, instantly interchangeable. Built in several standard ranges, 0-300 deg. F. to 0-1200 deg. F. Write for Bulletin 3514 giving complete description.

ILLINOIS TESTING LABORATORIES INC.
142 WEST HUBBARD STREET
CHICAGO 10, ILLINOIS

J-B-T

ROTARY SELECTOR SWITCHES



Positive action, non shorting type featuring contact arms, and on the twenty position switch, triple contacts on collector rings. Very compact. Fourteen to twenty positions —one to six decks. Normal current capacity (not make-and-break) one ampere at 25 volts D.C. Normal contact resistance approximately 0.005 ohms. Maximum safe voltage between contacts, 1000 volts A.C. Maximum voltage between decks, 2000 volts A.C. Maximum momentary carrying capacity (not make-and-break), five amperes at 25 volts D.C. Send for Bulletin SS-44.

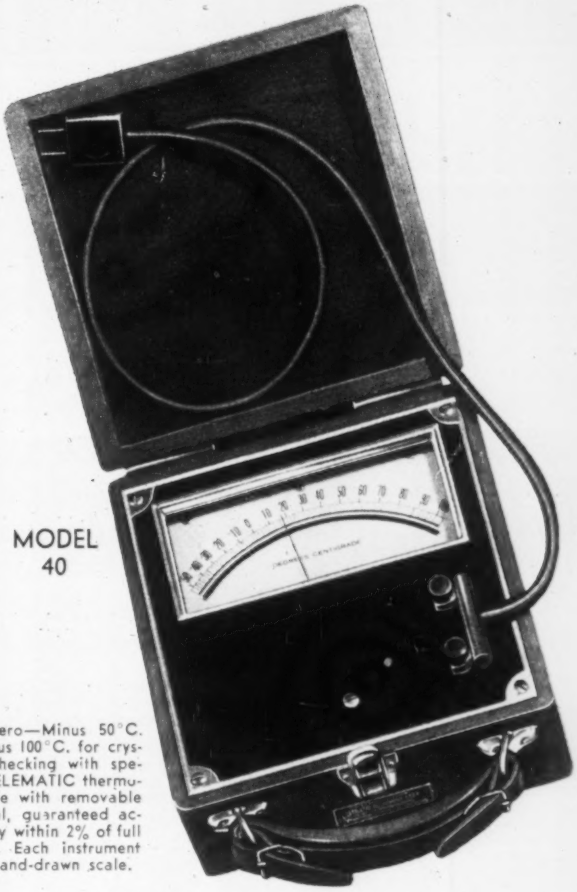
J-B-T *Products*

Vibrating Reed Frequency Meters... Pyrometers... Potentiometer-Pyrometers... Resistance Thermometers... Thermocouples and Accessories... Electric Tachometers... Galvanometers... Selector Switches...and other Electrical Instruments and Testing Equipment.

(Manufactured under Triplett Patents and/or Patents Pending)

J-B-T INSTRUMENTS, INC.
443 CHAPEL STREET • NEW HAVEN 8, CONN.

PORTABLE *High Resistance* PYROMETER



MODEL 40

Sub-zero—Minus 50°C. to Plus 100°C. for crystal checking with special ELEMATIC thermocouple with removable crystal, guaranteed accuracy within 2% of full scale. Each instrument has hand-drawn scale.

This instrument is enclosed in a finely finished walnut case with hinged removable cover and leather carrying handle. High resistance movement with internal shunt which retards pointer swing and prevents movement from being jarred out of balance in shipment. Mirror on scale to avoid parallax errors, 5¾″ scale, 6″ knife edge pointer, automatic compensation, two sapphire jewels and lapped pivots. All standard scale ranges and thermocouple accessories—$85.00 F.O.B. our plant (less thermocouples).

ELEMATIC EQUIPMENT
CORPORATION
6046 WENTWORTH AVE., CHICAGO 21, ILL.

PYRO THE SIMPLIFIED OPTICAL PYROMETER

ELIMINATE WASTE and GUESSWORK!

By using PYRO, a self-contained, DIRECT READING, sturdy unit made to stand rough use. It is absolutely accurate and dependable, and quickly pays for itself.

Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects, or smallest stream; no correction charts, no accessories, no maintenance expense. Special "FOUNDRY TYPE" and "Universal TRIPLE RANGE" have, in addition to standard calibrated range, a red correction scale determining TRUE SPOUT and POURING TEMPERATURES of molten iron and steel when measured in the open.

Stock ranges 1400° F. to 5000° F.

Write for Catalog No. 80

THE PYROMETER INSTRUMENT CO.
Plant & Lab.
103-107 LAFAYETTE ST., NEW YORK, N. Y.

PYCNOMETERS
- Eimer & Amend
- Fisher Scientific Co.
- G. M. Mfg. Co.
- Rascher & Betzold
- Specialty Glass Co.

PYRHELIOMETERS
- Cambridge Inst. Co.
- Eppley Lab.
- Leeds & Northrup Co.

PYROMETER CALIBRATING SETS
- Bristol Co.
- Brown Inst. Co.
- Cambridge Inst. Co.
- De Jur-Amsco
- Foxboro Co.
- Leeds & Northrup Co.
- Lewis Engineering
- Rubicon Co.
- Tagliabue Mfg. Co.
- Thwing-Albert Inst. Co.

PYROMETERS, Electrical Resistance
- Bailey Meter Co.
- Bristol Co.
- Brown Inst. Co.
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- Cole Instrument
- Dickson Co.
- Foxboro Co.
- General Elec. Co.
- Ill. Testing Labs.
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- Leeds & Northrup Co.
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- Roller-Smith Co.
- Rubicon Co.
- Tagliabue Mfg. Co.
- Thwing-Albert Inst. Co.
- Wheelco Inst. Co.

PYROMETERS, Expansion
- Defender Automatic Reg.
- Ferner Co.
- Partlow Corp.
- Tagliabue Mfg. Co.

PYROMETERS, Indicating
- Bacharach Indus. Inst.
- Bailey Meter Co.
- Bristol Co.
- Brown Inst. Co.
- Burling Inst. Co.
- Burrell Tech. Supply
- Cole Instrument
- De Jur-Amsco
- Electronic Prod. Co.
- Elematic Sales Corp.
- Engelhard, Chas.
- Foxboro Co.
- Ill. Testing Labs.

(Cont'd)

"Boys, let's put our heads together and see how much paper and paper board we can save!"

THAT'S the spirit. That's what we've all got to do to lick the problem of getting enough paper and paper board for Army and war-production use.

Every company has got to organize a Paper Conservation Committee and tackle the problem with all the gumption and the brain power at their command.

Paper inventories must be checked with the idea of eliminating peace-time extras. From stationery to board containers, every paper item must be examined to see in what way each company can use less paper.

Functional packaging must be the order of the day.

Sure, you have followed all the government directives on the subject. Even made cuts of your own. But, frankly, that isn't enough. Every time another ship leaves an American port loaded with paper wrapped war supplies, the problem becomes tougher.

And it's up to you to join with the rest of industry to lick it. The War Advertising Council and the War Production Board have prepared a brief list of suggestions to help you. But you know your own business. You know how you can use less paper. ***It's up to YOU!***

TO GET MORE PAPER FOR
- Blueprints for battleships
- "K" ration containers
- Signal Corps radio sets
- Containers for shells
- Gas mask canisters
- Disposable gun covers
- V-mail envelopes
- Blood plasma boxes

USE LESS PAPER THESE WAYS
- Eliminate slack fills.
- Increase units per case to the maximum practical.
- Reduce separators to shoulder height.
- Eliminate carton liners if possible.
- Eliminate individual cartons wherever possible.
- Reduce weight of containers whenever compatible with safety.
- Do away with all unnecessary overlapping.
- Set up a Paper Conservation Board in your plant.

This advertisement prepared under the auspices of the War Advertising Council in co-operation with the Office of War Information and the War Production Board.

Let's All Use Less Paper

...YOUR 4TH WAR LOAN QUOTA

WHETHER your plant meets its quota, or fails, lies largely in *your* hands. Your leadership can put it over—but if you haven't already got a smooth running, hard hitting War Loan Organization at work in your plant, there's not a minute to lose.

Take over the active direction of this drive to meet *—and break—*your plant's quota. And see to it that every one of your associates, from plant superintendent to foreman, goes all-out for Victory!

To meet your plant's quota means that you'll have to hold your present Pay-Roll Deduction Plan payments at their all-time high—plus such additional amounts as your local War Finance Committee has assigned to you. In most cases this will mean the sale of *at least* one $100 bond per worker. It means having a fast-cracking sales organization, geared to reach personally and effectively every individual in your plant. And it means hammering right along until you've reached a 100% record in those *extra* $100 —or better—bonds!

And while you're at it, now's a good time to check those special cases—*growing more numerous every day*—where increased *family* incomes make possible, *and imperative,* far greater than usual investment through your plant's Pay-Roll Deduction Plan. Indeed, so common are the cases of two, three, or even more, wage-earners in a single family, that you'll do well to forget having ever heard of '10%' as a reasonable investment. Why, for thousands of these 'multiple-income' families 10% or 15% represents but a paltry fraction of an investment which should be running at 25%, 50%, or more!

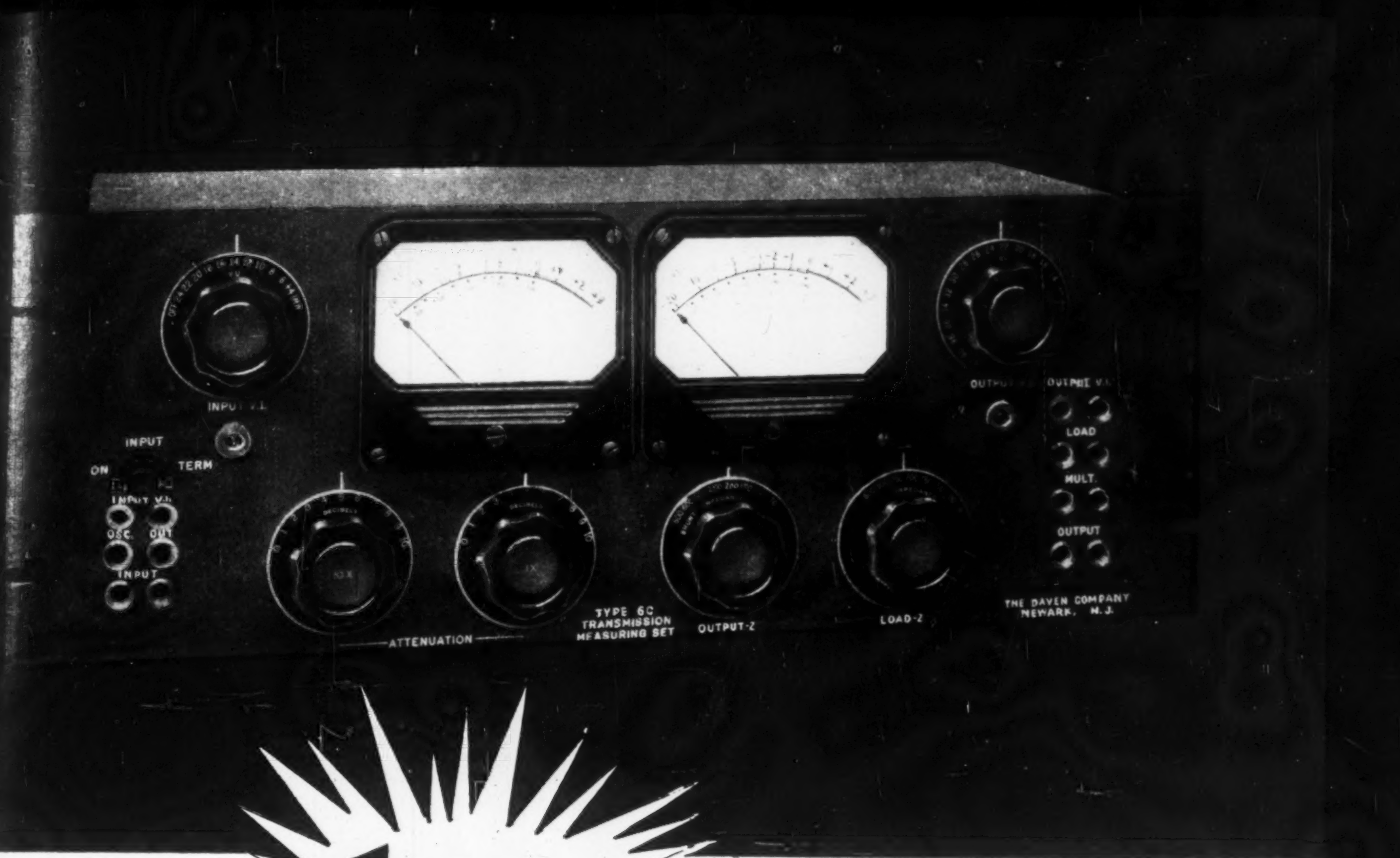
After the way you've gone at your wartime *production* quotas—and topped them every time—you're certainly not going to let anything stand in the way of your plant's breaking its quota for the 4th War Loan! Particularly since all you are being asked to do is to sell your own people the finest investment in the world—*their own share in Victory!*

LET'S ALL BACK THE ATTACK!

This space contributed to Victory by

INSTRUMENTS

This is an official U. S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council.


INPUT V.I.
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OUT
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ATTENUATION
TYPE 6C
TRANSMISSION
MEASURING SET
OUTPUT-Z
LOAD-Z
OUTPUT V.I.
OUTPUT V.I.
LOAD
MULT.
OUTPUT
THE DAVEN COMPANY
NEWARK, N.J.

in WAR....

performing our greatest peacetime task

Practically any reference to precision control in wartime brings to mind the wide use of DAVEN components in military and industrial applications. And yet, even now, our components are performing their greatest peacetime role. That is, control of radio transmission—not only for the major commercial broadcasting stations in this country, but for the communications transmitters which speed messages to all parts of the earth. DAVEN equipment will assume still greater importance in the postwar world of television, sound picture production and scientific laboratory development.

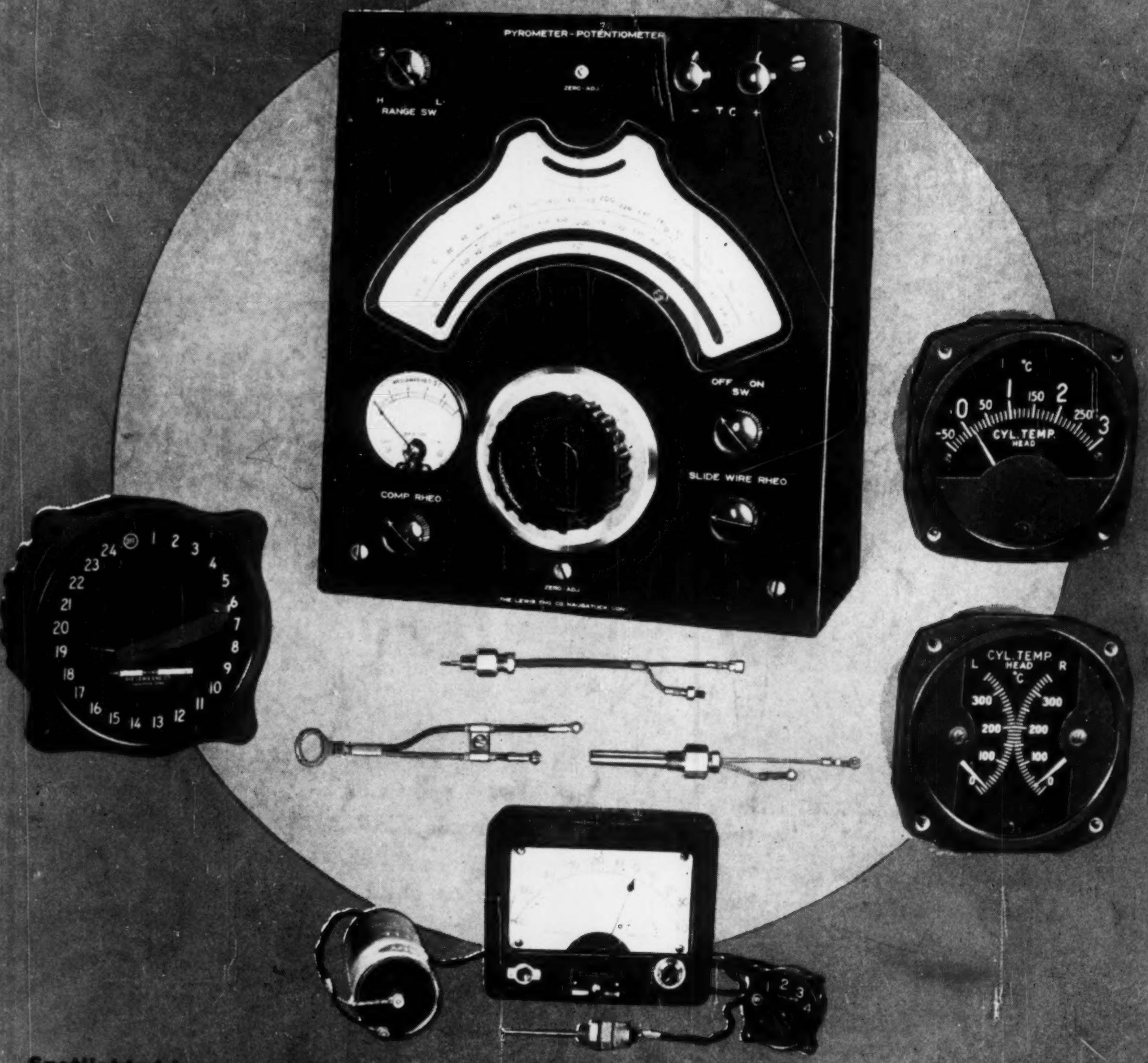
For many years, DAVEN has maintained a commanding position in a field where the standards for accurate control and measurement are set at the highest levels. Engineers specify DAVEN components where absolute dependability and extreme accuracy are essential. We produce not only the most complete line of precision attenuators in the world, but such specialized equipment as output power meters, transmission measuring sets, decade resistance boxes, volume level indicators and many other types of laboratory test equipment for electrical, broadcast, sound picture and television applications. May we send you a DAVEN catalog?

THE DAVEN COMPANY

191 CENTRAL AVENUE **NEWARK 4, NEW JERSEY**

BUY ANOTHER WAR BOND TODAY

'Made by Lewis'—YOUR GUARANTEE . . . of the best in Engine Temperature Measuring Instruments



PYROMETER - POTENTIOMETER
H L
RANGE SW
ZERO ADJ.
— T C +
OFF ON
SW
SLIDE WIRE RHEO
COMP RHEO
ZERO ADJ.
THE LEWIS ENG. CO. NAUGATUCK, CONN.
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CYL. TEMP
HEAD
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200 200
100 100
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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
1 2 3 4

Spotlighted here, around the famous Lewis pyrometer potentiometer, are a few of the Lewis instruments and accessories whose performance has earned the Lewis Engineering Company acknowledged leadership in the manufacture of engine temperature measuring instruments.

The rugged and versatile pyrometer potentiometer is used to measure cylinder head temperature, engine base temperature, oil, carburetor air, and free air temperatures. Also shown are typical models of Lewis rotary selector switches, resistance thermometers, standard thermocouples, extension leads, and thermocouple type engine cylinder temperature indicators. For complete data on these, and other Lewis instruments, write, on your company letterhead, for the Lewis aircraft instrument catalog.

THE LEWIS ENGINEERING COMPANY
NAUGATUCK, CONN.